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MOD 000-818-963

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464C-5335-JWH
October 31, 2002

BOEING

Mr. Patrick Quinn
Missouri Department of Natural Resources
Hazardous Waste Program
P.O. Box 176
Jefferson City, Missouri 65102

Encl: Revised Annual Monitoring Report for SWMU No. 17, October 29, 2002 (3 copies)

Dear Mr. Quinn;

Following are our responses to your October 17, 2002 comments on the Revised Annual Monitoring Report revisions for SWMU 17 dated September 17, 2002. Due to the numerous revisions, a complete revised report is provided. This replaces everything in the original report dated January 25, 2002 and subsequent revisions dated September 17, 2002, except for the appendices.

**Response to Comment # 1.:**

Table 6-8 has the correct values for the field parameters for TP-4 in 2001. The range of the pH is 9.60 to 10.3 which is noteworthy in comparison to the other samples. The range at TP-4 for conductivity and temperature in 2001 (848-3,070 µS/cm and 14.3-26.2 respectively) were comparable to the other samples and not noteworthy. The original text reflected the higher field parameter values measured in TP-4 in 1998. The text has been revised again to clarify this issue. Table 6-8 has also been revised to correct the units for conductivity; the actual units are µS/cm (micro Siemens per centimeter). The table had resistivity units (µohms/cm) incorrectly listed in the units column, the values in the table were correct.

ANNUAL MONITORING REPORT FOR SWMU NO. 17
MCDONNELL DOUGLAS HAZELWOOD, MISSOURI FACILITY

**Response to Comment # 2.**

Only the boring to the east of TP-20 will be completed as a monitoring piezometer if no step out borings are needed. If step out borings are required, one or more borings will be completed as monitoring piezometers. This monitoring point(s) will be established based on the location of the step out borings. The fourth paragraph in Section 7.3 on page 7-7 has been changed to reflect this. One soil sample and one groundwater sample from each boring will be analyzed for VOC's and TPH as indicated in paragraph three on page 7-7.

**Response to Comment #3.**

Various approaches to conducting risk assessments are being evaluated. If it is determined that risks need to be evaluated separately for the Former Fabrication Operations and Tract I South, the basis for doing so will be documented. Should new areas of concern, in addition to SWMU 17, be identified on City of St. Louis property, they will be addressed in any risk assessment or corrective measures study for Tract I South.

**Response to Comment # 4.**

The Investigative Threshold Levels tables have been revised. These new tables, which have been added to Section 7.3 as Table 7-1 and 7-2, will be used for the SWMU 17 investigation as well as the Former Fabrication Operation site and additional investigation at Tract I South. The EPA Region V Data Quality Levels column has been removed from the groundwater table. Values from EPA Region IX Preliminary Remediation Goals are used where no MCL or CALM GTARC values exist. These values are footnoted. The list of constituents on each ITL table has been expanded to include all of the identified constituents so that the tables are consistent.

**Response to Comment # 5.**

Tables 6-4 through 6-6 for soil sampling results have been updated to include the detection limits for all non-detections.

**Response to Comment # 6.**

Several figures (Figures 6-4, 6-6, 6-8, 6-9, 6-12, and 6-13) within the report have been re-submitted due to errors for data values listed on the figures. The figures were changed to match the correct analytical results presented in the report tables (Tables 6-4, 6-5, and 6-6). The specific updates made to each of the figures referenced above are listed below:

**Figure 6-4**
(February 2001 – VOC & TPH Concentrations in GW for SWMU No. 17)

- For MW9S the Purgeables (13) value was removed because the correct value is a non-detect.

**Figure 6-6**
(September/October 2001 – VOC & TPH Concentrations in GW for SWMU No. 17)

- Added the September to Title to reflect that samples were collected in both September and October 2001.
- TP-9: the PCE and TCE values (0.92J and 0.015J, respectively) were removed because the correct values for the sample are non-detects for these constituents.
- TP-7: the PCE and TCE values (0.37J and 0.031J, respectively) were removed because the correct values for the sample are non-detects for these constituents.
- TP-6: the PCE value (0.66J) was removed because the correct value for the constituent is a non-detect.

**Figure 6-8**
(Shallow GW Elevation Contours for SWMU No. 17 - February 2001)

- MW9S was changed as listed above for Figure 6-4. Additionally, the sample analysis result for Diesel (value of 2.4) was placed on the figure since it had been inadvertently left off.

**Figure 6-9**
(Intermediate GW Elevation Contours For SWMU No. 17 - February 2001)

- MW9S was changed as listed above for Figure 6-4. Additionally, the sample analysis result for Diesel (value of 2.4) was placed on the figure since it had been inadvertently left off.

464C-5335-JWH
31 October 2002

**Figure 6-12**
(Shallow GW Elevation Contours for SWMU No. 17 - October 2001)

- TP-9, TP-7, and TP-6 were changed as listed above for Figure 6-6.

**Figure 6-13**
(Intermediate GW Elevation Contours for SWMU No. 17 - October 2001)

- TP-9, TP-7, and TP-6 were changed as listed above for Figure 6-6.

**Response to Comment # 7.**

Figure 7-2 was re-submitted due to errors for data values listed on the figure. The figure was corrected to match the correct analytical results presented in the report tables (Tables 6-5 and 6-6). The specific changes to Figure 7-2 are listed below:

**Figure 7-2**
(Approximate Delineation of Constituents Above ITL's in GW)

- TP-9 and TP-7 were changed as listed for Figure 6-6.
- TP-6 was changed as listed for Figure 6-6. Additionally, the value for the December sampling analytical result for TCE (2.9) was placed on the figure since it had been inadvertently left off.

Please contact me should you need additional information.

Sincerely,

Joe Haake

Joseph W. Haake, Group Manager
Environmental and Hazardous Materials Services
Dept. 464C, Bldg. 220, Mailcode S221-1400
(314) 232-6941

cc: Jerome Johnson

# ANNUAL MONITORING REPORT for SWMU NO. 17 MCDONNELL DOUGLAS HAZELWOOD, MISSOURI FACILITY

***Prepared for:***

***McDonnell Douglas***
***(A wholly owned subsidiary of The Boeing Company)***
***St. Louis, Missouri***

*Prepared by:*

*Harding ESE, Inc.*
*St. Louis, Missouri*

***October 29, 2002***

***Harding ESE Project No. 517042-0500***

# Annual Monitoring Report for SWMU No. 17 McDonnell Douglas, Hazelwood, Missouri Facility

Prepared for:
McDonnell Douglas Corporation
(a wholly owned subsidiary of The Boeing Company)
St. Louis, Missouri

Prepared by:
Harding ESE, Inc.
St. Louis, Missouri

October 29, 2002

Harding ESE Project No. 517042-0500

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## List of Appendices

# 1.0 INTRODUCTION

This document represents the 2001 Annual Monitoring Report (2001 Annual Report) for Corrective Action activities completed for Solid Waste Management Unit No. 17 (SWMU No. 17) at the McDonnell Douglas (MD) facility. This unit is also known as the former Transfer Area for Recovered PCE. The MD Tract I facility (Facility) is located in Hazelwood, Missouri. The Facility location is presented in Figure 1-1.

The Facility is subject to the requirements of Corrective Action as outlined in the final RCRA Part B Permit No. MOD000818963. This permit was issued by the Missouri Department of Natural Resources (MDNR) on March 5, 1997 pursuant to Section 3004(u) of RCRA. This 2001 Annual Report has been prepared in accordance with Corrective Action Permit Conditions I, VI, and XIV and the MDNR-approved RFI Work Plan dated November 24, 1997.

Further guidance, as needed, was obtained from documents including the "RCRA Facility Investigation Guidance" (EPA 530/SW89-031), "Test Methods for Evaluating Solid Waste" (SW-846), and other relevant U.S. Environmental Protection Agency (USEPA) publications. This 2001 Annual Report fully complies with the Corrective Action requirements of the Facility's Part B Permit.

## 1.1 Purpose

This 2001 Annual Report documents the investigation activities conducted to characterize the nature of any hazardous waste/constituent releases to soil or groundwater from SWMU 17 as prescribed in the RFI Workplan Addendum and Workplan Addendum II. This 2001 Annual Report will provide MDNR/USEPA personnel with MD's evaluation and conclusions regarding the RFI investigation data. Upon review and approval by MDNR, this Report will serve as a reference document and database for planning future Corrective Action activities at the Facility, as needed.

## 1.2 Organization of 2001 Annual Report

This 2001 Annual Report is divided into eight sections of text plus four appendices. A brief description of each section is presented below.

Section 1.0, **Introduction**, provides background information regarding the RCRA requirements for the Facility, purpose of this Report, and contents of this Report.

Section 2.0, **Facility Background Information**, references background information regarding the Facility and its environmental setting.

Section 3.0, **Summary of Previous Site Data**, summarizes the findings and results of previous evaluations/investigations for SWMU No. 17.

Section 4.0, **RFI Objectives and Supporting Data Requirements**, summarizes the site-specific investigation objectives, identifies the target constituents and associated investigation threshold levels (ITLs) for the RFI, and describes the established data quality objectives for the investigation.

Section 5.0, **2001 Field Activities**, summarizes the RFI field activities and describes the procedures that were utilized for all field sampling and laboratory analysis tasks.

Section 6.0, **2001 Results**, summarizes the geological, hydrogeological, and analytical results of the 2001 site investigation/monitoring activities.

Section 7.0, **Summary and Conclusions**, summarizes the investigation results to date, presents conclusions which address the RFI objectives, and provides recommendations for future Corrective Action at the unit.

Section 8.0, **References**, provides a list of references used within the text of this Report.

Four appendices are also provided to describe associated RFI activities. Appendices to this document are identified below.

Appendix A **Soil Boring, Temporary Piezometer, and Monitoring Well Logs**
Appendix B **Analytical Laboratory Results and Data Validation Reports**
Appendix C **Geotechnical Lab Results**
Appendix D **Pump Test Calculations**

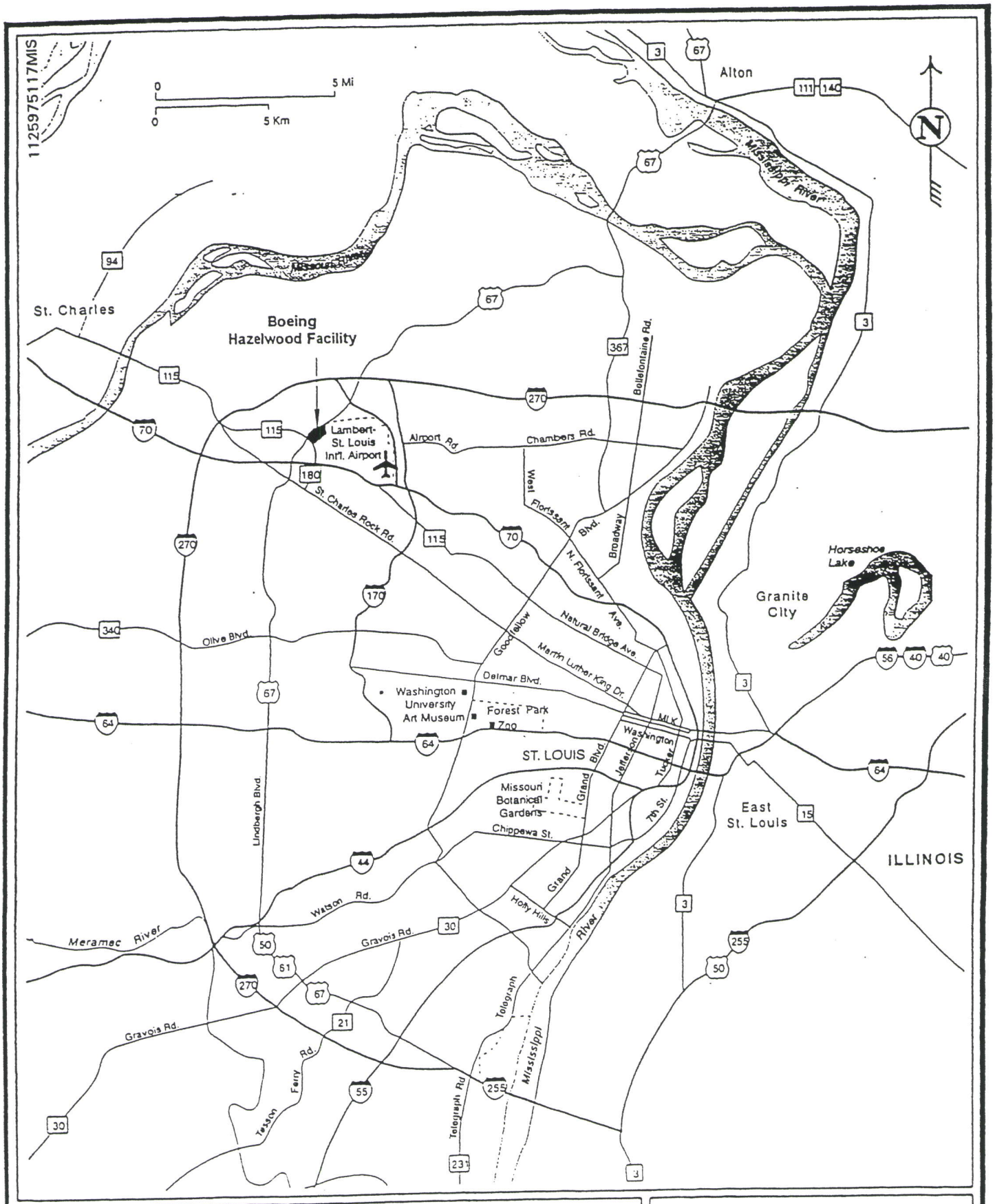



Figure 1-1
FACILITY LOCATION MAP
BOEING FACILITY
HAZELWOOD, MO

Harding ESE
A MACTEC COMPANY

# 2.0 FACILITY BACKGROUND INFORMATION

This section of the 2001 Annual Report presents background information pertaining to the operational history and environmental setting for the Facility.

## 2.1 Site Description

The MD Tract I facility is located in Hazelwood, St. Louis County, Missouri. It is located within Section 5, Township 46N, Range 6E. The Facility is generally bounded on the south by Lambert St. Louis International Airport, on the east by the MD Tract II facility, on the west and northwest by Lindbergh Boulevard, and on the northeast by McDonnell Boulevard.

## 2.2 Facility Operations

MD manufactures combat aircraft, transport aircraft, and space systems/missiles. The primary product produced at the Facility is combat aircraft, including the F-15 Eagle, the F/A-18 Hornet, and the AV-8B Harrier. Other products produced at the Facility include the T45TS trainer, missile systems, and components for the C-17 transport plane.

Access to the Facility is strictly controlled. The Facility is surrounded by a chain-link fence and is patrolled by a security force 24 hours a day, 365 days per year. Employees and visitors must pass through security gates at the main entrance to the Facility before entering any building. The security force employs approximately 225 persons, and an on-site fire department employs approximately 30 persons.

MD began operations in 1941 and presently employs approximately 15,000 people. Currently, the Facility operates 24 hours a day, Monday through Friday, as well as periodic weekend shifts. Activities performed in support of MD operations include chemical processing, metal cutting, metal forming/grinding, degreasing, painting, aircraft assembly, aircraft fueling, and aircraft flight testing.

MD is a large quantity generator of hazardous waste. MD generates approximately 48 different waste streams that the Facility classifies as hazardous waste. The largest waste quantities generated consist of paint solids, solvent and paint waste, wastewater treatment sludge, acid waste, and caustic waste.

MD stores hazardous waste in drums and dumpsters at various locations around the Facility. Drums of hazardous waste generated on-site are stored at one of two less-than-90-day storage areas. These areas are located at Building 41 and Building 11A. Waste solvents, paints, and oils are accumulated in drums at various satellite accumulation locations. When full, the containers are transferred to one of the less-than-90-day storage areas.

## 2.3 Environmental Setting

A preliminary evaluation of the environmental setting at the Facility was completed as part of the RFI Workplan to better understand the framework for migration of any potential constituent releases and the potential effects on human health and the environment. This information is presented below.

### 2.3.1 General Setting

The Facility is surrounded by Lambert-St. Louis International Airport on the south, commercial and industrial facilities on the west and north, and the MD Tract II Facility on the east. According to information obtained from the MDNR, Division of Geology and Land Survey, no wells are located within a 1-1/2-mile radius of the Facility (RFA, 1995). Surface water from the Facility drains toward Coldwater Creek which flows along the Facility's eastern boundary.

### 2.3.2 Geology

Subsurface geologic units in the area of the Facility include wind or lake-deposited sediments (unconsolidated deposits) overlying nearly flat-lying sedimentary bedrock formations. These deposits may be up to 100 ft thick and consist of clay, silty clay, and some sand (Lutzen and Rockaway, 1971).

Unconsolidated deposits in the area of the Facility have been delineated by previous hydrogeologic studies conducted at the Facility (ATEC, 1990 and Riedel, 1995), as well as studies conducted at the James River Paper Company (formerly Crown-Zellerbach) located approximately 1,200 feet northwest of the Facility, and the St. Louis Airport Site (SLAPS) which adjoins the Facility to the east along Coldwater Creek. The uppermost unconsolidated deposits consist of interbedded clay, silty clay, and clayey silt with some fine-grained sand and organic matter. A dense, plastic, brown to gray-green clay unit can be present with the interbedded silty deposits. Soil sampling was conducted to a depth of approximately 30 feet at the Industrial Wastewater Treatment Plant (IWTP); results indicated the predominance of clay soils.

In areas at both facilities (MD and James River Paper Co.), up to 14 feet of clayey silt or silty clay fill material is present over the unconsolidated sequence. The fill material is composed of material either excavated at the site or brought in as clean fill during plant construction and modification activities.

The uppermost bedrock encountered in the area of the Facility is the undifferentiated Pleasanton, Marmaton, and Cherokee Groups of Pennsylvanian age. Shales, siltstones, sandstones, coal beds, and thin limestone beds are the dominant lithology of these three groups. Regionally, the Pennsylvanian-age groups have a total thickness ranging from 10 to 300 feet.

Underlying the Pennsylvanian strata is Mississippian-age limestone. The Ste. Genevieve Formation (0 to 160 feet thick), St. Louis Limestone (0 to 180 feet thick), Salem Formation (0 to 180 feet thick), and Warsaw Formation (0 to 110 feet thick) are all limestone and compose the upper portion of the Mississippian-age bedrock.

### 2.3.3 Hydrogeology

Water supplies in the St. Louis area are obtained from the Mississippi, Missouri, and Meramec Rivers. Approximately 82 percent of the water supply is pumped from the Mississippi River, while approximately 12 percent is pumped from the Missouri River and Meramec River combined (Miller *et al.*, 1974). Aquifers exist in both the bedrock and unconsolidated deposits along the Mississippi and Missouri Rivers. These aquifers account for approximately 3 percent of the water supply (Miller *et al.*, 1974).

As stated above, the Facility is underlain by 30+ feet of low permeability clay and silt. This material has little potential to produce water. In the vicinity of Building 40, shallow groundwater was encountered at 2 to 8 feet below land surface (bls). One notable exception was apparent in the vicinity of the IWTP where shallow groundwater was encountered at approximately 30-40 ft bls.

The shallow groundwater table may be modified locally at the Facility due to the presence of buildings or parking lots. Overall, the shallow groundwater flow direction is expected to move towards Coldwater Creek or ditches draining into this creek. Given the low permeability and thickness of the unconsolidated deposits underlying the Facility, a direct connection to deeper bedrock aquifers is not expected.

### 2.3.4 Surface Water Hydrogeology

General surface water drainage at the Facility is by overland flow to storm sewer intakes located across the Facility or to open drainage ditches that drain to storm sewers. The storm sewers discharge into Coldwater Creek at several locations. Coldwater Creek flows northeast within an underground culvert from the southwest side of Lambert-St. Louis International Airport, across the central portion of the airport, and the easternmost part of Tract I South. The creek flows within an open culvert north of Banshee Road along the eastern boundary of Tract I North. Coldwater Creek then flows northeast within this open culvert for several miles until it rejoins its original channel. The creek eventually

discharges into the Missouri River. At its closest point, the Missouri River is approximately 3 miles to the northwest of the Facility.

Presently, approximately 90 to 95 percent of the surface area is covered with buildings, paved streets, paved parking lots, tankfarms, and docks. Many of the aboveground structures associated with discontinued processes have been demolished, although concrete at or below grade remains. An extensive network of utilities including potable and service water lines, storm sewers, sanitary sewers, and other utilities (typical of an industrial facility) remains underground even though significant portions are no longer used, or are isolated from active lines.

## 2.4 Additional Sources of Background Information

Historic evaluations of the geology and hydrogeology at the Facility were conducted as part of previous investigations to better understand the framework for migration of any potential constituent releases and the potential effects on human health and the environment. A prior report entitled McDonnell Douglas Corporation RCRA Closure Activities, Building 14: Sludge Holding Tank Site (Riedel Environmental Services, Inc., 1995) should be referenced for additional information pertaining to the environmental setting at the Facility.

# 3.0 SUMMARY OF PREVIOUS SITE DATA

This section summarizes results acquired from site evaluations that were conducted prior to 2001. These results assisted in the development of the investigation approach for SWMU No. 17 in order to attain the RFI objectives. In addition, this section of the 2001 Annual Report provides background information pertaining to the operational history and current usage for SWMU No. 17.

In compliance with Corrective Action requirements for the Facility, MD submitted the RFI Workplan and associated support plans (Health and Safety Plan [HASP] and Quality Assurance Project Plan [QAPP]) to MDNR for initial review in May 1997. The Workplan provided a summary of existing Facility conditions and the proposed procedures/methodologies for the RFI activities. Subsequent revisions were made to the Workplan based on comments received from MDNR. Approval of the revised November 1997 document was provided in January 1998. Supplemental RFI activities were subsequently proposed/approved in April 1998, March 2000, and July 2001 to enhance delineation of chemical constituents at SWMU No. 17 (Transfer Area for Recovered PCE).

This section of the 2001 Annual Report describes the findings from prior investigations that were used to establish the basis for the supplemental field investigation efforts in 2001.

## 3.1 RFA Findings

Limited soil sampling activities were conducted as part of the RFA to preliminarily assess whether any releases have occurred from this unit. Two shallow soil samples (0-12 inches bls and 12-24 inches bls) were collected from one soil boring for off-site laboratory analysis.

Four VOC constituents including PCE (760 to 290,000 $\mu$g/kg), acetone (88 to 140 $\mu$g/kg), total xylenes (11 to 32 $\mu$g/kg), and 1,2-dichloroethene (1,2-DCE) (14 to 44 $\mu$g/kg) were detected in the samples and sample duplicates acquired from this unit. The shallower sample exhibited the highest PCE concentration of 290,000 $\mu$g/kg, while the field duplicate for the same depth interval exhibited a lower PCE concentration of 40,000 $\mu$g/kg.

Inorganic constituents were detected in the samples acquired from this unit. However, arsenic and selenium represent the only inorganic constituents which exceeded USGS-based regional background levels. Arsenic was detected in the deeper sample at a concentration of 46.3 mg/kg, while selenium was detected in the shallower sample at a concentration of 4.02 mg/kg.

## 3.2 RFI Findings to Date

Pre-2001 geological soil boring data, analytical soil data, analytical groundwater data, groundwater elevation measurements, and various field data have been utilized to characterize the nature and extent of any hazardous waste/constituent impacts from SWMU No. 17.

### 3.2.1 Analytical Results for SWMU No. 17 Soil Samples

Analytical results for SWMU No. 17 soil samples collected prior to 2001 were utilized to assess the horizontal and vertical extent of any impacted soils at this unit. Analytical results for soil samples collected from the western, southern, and eastern portions of SWMU No. 17 are summarized in Tables 3-1, 3-2, and 3-3, respectively. Soil sample locations and associated results are displayed in Figure 3-1.

Ten (10) borings were advanced in the initial phase of the investigation (1998) to assess the extent of any releases from SWMU No. 17. Several of the soil borings exhibited PID/visual evidence of VOC-related impacts, thus necessitating the completion of additional "step-out" borings. At these locations, the impacted boring was plugged and a new boring was advanced at a location of 20-30 ft further away from the source area. In this manner, the horizontal extent of SWMU No. 17 was extended further in an easternly direction.

Thirteen (13) additional borings were completed in the supplemental phase (December 2000). Three step-out borings (SB-15, SB-16, and SB-17) were completed to delineate the eastern downgradient extent of SWMU No. 17, as well as one step-out boring (SB-18) within the suspected source area inside of Building 51. Two upgradient borings (SB-13 and SB-19) were also advanced to the west.

Soil samples were collected from each of the borings and submitted for chemical analysis to delineate the horizontal and vertical extent of SWMU No. 17. Twelve (12) VOC constituents including perchloroethene (PCE), trichloroethene (TCE), cis-1,2-dichloroethene (cis-1,2-DCE), trans-1,2-dichloroethene (trans-1,2-DCE), 1,1,2-trichloroethane, acetone, methylene chloride, 2-butanone, toluene, xylenes, ethylbenzene, and various benzene derivatives were detected in samples acquired from this area. The highest VOC concentrations were detected at soil borings SB-1, SB-2, SB-3, SB-4, SB-11, and SB-18 within the most interior portions of the unit. Soil samples from SB-18, SB-11, SB-4, and SB-1 exhibited the highest PCE concentrations of 9,300 ppm, 1,700 ppm, 240 ppm, and 58 ppm, respectively. Soil samples from SB-18, SB-11, and SB-4 contained 68 ppm, 57 ppm, and 11.9 ppm cis-1,2-DCE, respectively. Soil samples from SB-7 along the southwest portion of the area and SB-5 along the northeast portion of the area exhibited PCE concentrations of 4.2 ppm and 3.6 ppm, respectively.

Although collected from saturated intervals, soil samples from a deeper boring (SB-9) were also analyzed. While PCE was not detected in any of the SB-9 samples, several other VOC constituents were detected. Saturated soil samples from SB-9 exhibited maximum concentrations of 12 ppm TCE and 0.38 ppm 1,1,2-trichloroethane.

Twenty three (23) of the thirty six soil samples collected from SWMU No. 17 contained concentrations which exceeded at least one VOC ITL. Six VOC constituents exceeded ITLs (cis-1,2-DCE, trans-1,2-DCE, methylene chloride, perchloroethene, 1,1,2-trichloroethane, and TCE).

Eight (8) soil samples were also analyzed for other non-RCRA related parameters. Soil samples from SB-12, SB-5, and SB-15 along the eastern portion of the unit exhibited the highest extractable hydrocarbon concentrations of 6,360 ppm (diesel calibration), 1,900 ppm, and 470 ppm (diesel calibration), respectively. Soil samples from SB-12, SB-5, and SB-6 contained 260 ppm (gasoline), 180 ppm, and 25 ppm, respectively. Soil samples to the east (SB-12, SB-15, SB-16) and northeast (SB-5, SB-6) of SWMU No. 17 exhibited total purgeable and/or total extractable hydrocarbon concentrations that exceeded ITLs.

Seven of eight heavy metal constituents were detected for samples acquired from SWMU No. 17. Concentrations were comparable to background values. Maximum concentrations for the unit included 20 ppm arsenic, 310 ppm barium, 0.9 ppm cadmium, 22 ppm chromium, 16 ppm lead, 0.56 ppm mercury, and 1.6 ppm selenium. None of the soil samples from SWMU No. 17 contained constituent concentrations which exceeded metals ITLs.

The maximum detected values for the SWMU No. 17 soil samples were compared to the constituent-specific ITL values to evaluate the presence of significant constituent concentrations. Six (6) VOC constituents exceeded the corresponding ITL values for soils. In addition, three other VOCs (benzene, 1,1-DCE, and vinyl chloride) exceeded the corresponding ITL values for groundwater. As a result, the following COCs at SWMU No. 17 were retained for further evaluation:

- VOCs (9): benzene, 1,1-DCE, cis-1,2-DCE, trans-1,2-DCE, PCE, 1,1,2-trichloroethane, TCE, vinyl chloride, and methylene chloride.

### 3.2.2 Analytical Results for SWMU No. 17 Groundwater Samples

Analytical results for SWMU No. 17 groundwater samples were utilized to characterize the nature and extent of constituent releases to groundwater beneath this unit. Analytical results for groundwater samples collected from SWMU No. 17 are summarized in Table 3-4. Groundwater sample locations and associated results for the April 1998 and December 2000 events are displayed in Figure 3-2.

Six groundwater samples were collected from SWMU No. 17 during the initial investigation phase for chemical analysis. Groundwater samples from four of the temporary piezometers (TP-1, TP-2, TP-3, and TP-4) and monitoring well MW-6S provided analytical data regarding shallow groundwater conditions. The groundwater sample acquired from MW-5I was used to characterize groundwater conditions from an intermediate portion of the saturated unit.

Six (6) groundwater samples were collected from SWMU No. 17 during the supplemental investigation phase for chemical analysis. Groundwater samples from three of the soil boring holes (SB-13, SB-17, SB-18), one of the temporary piezometers (TP-5), and two monitoring wells (MW-9S, MW-10S) provided analytical data regarding shallow groundwater conditions.

Fourteen (14) VOCs were detected in groundwater samples collected from SWMU No. 17. Three of the sampling locations which exhibited the highest VOC concentrations were situated within and immediately downgradient to the unit (TP-1, TP-2, and MW-5I). Groundwater samples from TP-1, MW-5I, TP-5, and TP-2 exhibited the highest total VOC concentrations of 317 ppm, 146 ppm, 105 ppm, and 58 ppm, respectively. The groundwater sample from TP-4 along the southwest corner of the unit also contained 17 ppm total VOCs. A downgradient boundary point was established to the northeast of SWMU No. 17 where no solvent-related VOCs were detected from TP-3.

PCE and several degradation products including TCE and cis-1,2-DCE were detected at the highest concentrations. Groundwater samples from TP-1 and TP-2 exhibited the highest PCE concentrations of 210 ppm and 45 ppm, respectively. The sample from TP-1 also contained the highest cis-1,2-DCE level of 97 ppm. Located approximately 70 feet downgradient (east) from TP-1, the groundwater sample from MW-5I exhibited the highest TCE concentration of 140 ppm (April 1998).

Analytical results for the adjacent shallow and intermediate monitoring wells (MW-6S and MW-5I, respectively) were also compared. Detected VOCs for the two wells were similar. However, the TCE concentration for the intermediate well MW-5I (140 ppm for the April 1998 event) was significantly higher than the comparable value for MW-6S (0.37 ppm). In addition, vinyl chloride was only detected at these two SWMU No. 17 groundwater sampling locations. Groundwater samples from MW-6S and MW-5I in April 1998 exhibited vinyl chloride concentrations of 0.94 ppm and 0.25 ppm, respectively. Other VOC constituents including acetone, benzene, ethylbenzene, methylene chloride, toluene, and xylenes were generally detected at low concentrations, e.g. 50 ppb or less, and/or on an isolated basis. Detected levels for acetone and methylene chloride in particular are likely to be laboratory artifacts.

The maximum concentration values were determined for the set of temporary piezometers/monitoring wells at SWMU No. 17. These maximum values for the groundwater samples were compared to the constituent-specific ITL values to evaluate the presence of significant constituent concentrations in groundwater. Although methylene chloride was likely associated with laboratory carryover, it was also retained for analysis in the supplemental investigation effort. As a result, the following groundwater-associated COCs at SWMU No. 17 were retained for further evaluation:

- VOCs (9): benzene, 1,1-DCE, cis-1,2-DCE, trans-1,2-DCE, PCE, 1,1,2-trichloroethane, TCE, vinyl chloride, and methylene chloride.

### 3.2.3 Groundwater Field Measurements for SWMU No. 17

In addition to the collection of samples for laboratory analysis, groundwater samples were also evaluated for the following field parameters: pH, conductivity, and temperature. These results are summarized by parameter below.

pH values for SWMU No. 17 groundwater samples ranged from 6.2 to a high of 12.9. Most values generally ranged from pH 6.5 -7.5. The strongly basic value of 12.9 was detected from TP-4 to the southwest of the unit. This reading represents the only pH value which indicates the presence of potentially abnormal groundwater conditions.

Conductivity values for SWMU No. 17 groundwater samples ranged from 1,300 - 101,000 us/cm. Most values generally ranged from 1,300 - 14,500 us/cm. The high end value of 101,000 us/cm was detected from TP-4 to the southwest of the unit. This reading represents the only conductivity value which indicates the presence of potentially abnormal groundwater conditions.

Temperature values for SWMU No. 17 groundwater samples ranged from 8 - 17°C. The lowest values were recorded during the February 1998 monitoring events while the highest values were recorded during the April 1998 monitoring event. None of the temperature results indicates the presence of any abnormal groundwater conditions.

## 3.3 Summary of Previous Investigations

Pre-2001 investigations/evaluations at SWMU No. 17 indicated that potential VOC and TPH releases occurred from this unit. Based on these results, additional RFI monitoring efforts were performed in 2001 to further delineate the nature and extent of potential releases at SWMU No. 17 that were not fully characterized in previous evaluations.

**TABLE 3-1**

**Detected Constituent Concentrations for Pre-2001 SWMU 17 Soil Samples**
**(Western Portion of Unit)**
**McDonnell Douglas RFI**

| | | SAMPLE ID NUMBERS AND RESULTS | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | S17B1 | | | | S17B2 | | S17B3 | S17B4 | | | S17B5 | | *INVESTIGATION THRESHOLD* |
| CONSTITUENT | UNITS | (2.5' - 4') | (2.5' - 4' Dupe) | (12' - 13') | (16' - 17') | (3' - 4.5') | (11' - 12.5') | (10.5' - 11.5') | (6' - 7') | (11.5' - 13.5') | (14' - 16') | (5.5' - 7') | (14' - 16') | *LEVEL (ITL)* |
| *Volatile Organics* | | | | | | | | | | | | | | |
| Acetone | ug/kg | 240 | 1600 U | 21 | 20 | 25 | 13 U | 16 | 27 | 14 U | 400 | 42 | 77 U | *16,000* |
| 2-Butanone | ug/kg | | | | | | | | | | | | | *5,200* |
| cis-1,2-Dichloroethene | ug/kg | 3200 U | 810 U | 22 | 88 | 6.5 U | 46 | 24 | 13 | 760 | 11,900 | 6.5 U | 280 | *400* |
| trans-1,2-Dichloroethene | ug/kg | 9.6 | 36 | 6.4 U | 6.8 U | 6.5 U | 6.4 U | 6.7 U | 7.2 U | 6.7 U | 19000 U | 6.5 U | 38 U | *700* |
| Ethylbenzene | ug/kg | | | | | | | | | | | | | *13,000* |
| Methylene chloride | ug/kg | | | | | | | | | | | | | *20* |
| Perchloroethene | ug/kg | 24,000 | 32,000 | 9,100 | 58,000 | 18,000 | 1,100 | 3,000 | 12,000 | 200,000 | 240,000 | 35 | 3,600 | *60* |
| Toluene | ug/kg | | | | | | | | | | | | | *12,000* |
| 1,1,2-Trichloroethane | ug/kg | | | | | | | | | | | | | *20* |
| Trichloroethene | ug/kg | | | | | | | | | | | | | *60* |
| Xylenes, Total | ug/kg | 41 | 230 | 6.4 U | 7.7 | 6.5 U | 6.4 U | 6.7 U | 180 | 6.7 U | 19000 U | 6.5 U | 38 U | *200,000* |
| Total Purgeable Hydrocarbons | mg/kg | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 180 | NA | *200* |
| Total Extractable Hydrocarbons | mg/kg | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 1,900 | NA | *200* |
| *Metals/Inorganics* | | | | | | | | | | | | | | |
| Arsenic | mg/kg | 10 | 6.4 U | 20 | 15 | 10 | 11 | 6.6 U | 20 | 7.2 U | 9.7 | NA | 7.6 U | *77* |
| Barium | mg/kg | 210 | 160 | 100 | 110 | 310 | 80 | 170 | 130 | 79 | 86 | NA | 82 | *1,750* |
| Cadmium | mg/kg | 0.63 U | 0.64 U | 0.65 | 0.68 U | 0.88 | 0.63 U | 0.66 U | 0.67 U | 0.72 U | 0.75 U | NA | 0.76 U | *8* |
| Chromium | mg/kg | 19 | 18 | 21 | 21 | 22 | 12 | 14 | 21 | 13 | 13 | NA | 12 | *85* |
| Lead | mg/kg | 15 | 8.5 | 13 | 11 | 11 | 11 | 8.9 | 16 | 9.8 | 7.5 | NA | 9 | *400* |
| Mercury | mg/kg | 0.03 U | 0.48 | 0.05 | 0.56 | 0.54 | 0.52 | 0.53 | 0.55 | 0.55 | 0.55 | NA | 0.05 | *2* |
| Selenium | mg/kg | 1.2 | 1.4 | 1 | 0.68 U | 0.86 | 0.63 U | 0.66 U | 0.67 U | 0.72 | 0.74 U | NA | 1.6 | *5* |

| | | SAMPLE ID NUMBERS AND RESULTS | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | S17B9 | | | | | S17B10 | | | S17B11 (TP-5) | | S17B14 (MW-7S) | S17B18 | | *INVESTIGATION THRESHOLD* |
| CONSTITUENT | UNITS | (26' - 27') | (26' - 27' Dupe) | (34' - 35') | (41' - 42') | (44' - 45') | (4' - 5') | (10.5' - 11.5') | (14' - 15') | (7' - 8') | (15' - 16') | (14' - 15') | (11' - 12') | (15' - 16') | *LEVEL (ITL)* |
| *Volatile Organics* | | | | | | | | | | | | | | | |
| Acetone | ug/kg | 39 | 48 | 40 | 16 | 34 | 26 | 13 U | 180 | 100 U | 130 | NA | 10 U | 130 | *16,000* |
| 2-Butanone | ug/kg | 12 U | 12 U | 6.2 U | 6.5 U | 6.5 U | 13 U | 6.3 U | 50 | 100 U | 10 U | NA | 10 U | 100 U | *5,200* |
| cis-1,2-Dichloroethene | ug/kg | 150 | 110 | 6.2 U | 13 | 17 | 6.3 U | 6.3 U | 7.4 U | 500 | 57,000 | NA | 140 | 68,000 | *400* |
| trans-1,2-Dichloroethene | ug/kg | 6.2 U | 6.2 U | 6.2 U | 6.5 U | 6.5 U | 6.3 U | 6.3 U | 24 | 50 U | 7,200 | NA | 5 U | 5,000 U | *700* |
| Ethylbenzene | ug/kg | 6.2 U | 6.2 U | 6.2 U | 6.5 U | 6.5 U | 6.3 U | 6.3 U | 7.4 U | 50 U | 49 | NA | 5 U | 400 | *13,000* |
| Methylene chloride | ug/kg | 19 B | 26 B | 22 B | 18 B | 16 B | 24 | 6.3 U | 69 | 28 J,B | 5 B | NA | 8 B | 43 J,B | *20* |
| Perchloroethene | ug/kg | 6.2 U | 6.2 U | 6.2 U | 8.0 | 6.1 | 6.3 U | 6.3 U | 7.4 U | 1,700,000 | 440 J | NA | 600 | 9,300,000 | *60* |
| Toluene | ug/kg | 6.2 U | 6.2 U | 6.2 U | 6.5 U | 6.5 U | 6.3 U | 6.3 U | 7.4 U | 50 U | 650 | NA | 5 U | 1,600 | *12,000* |
| 1,1,2-Trichloroethane | ug/kg | 180 | 330 | 18 | 6.5 U | 6.5 U | 6.3 U | 6.3 U | 7.4 U | 50 U | 5 U | NA | 5 U | 50 U | *20* |
| Trichloroethene | ug/kg | 12,000 | 8,200 | 39 | 1,300 | 7,900 | 9.3 | 64 | 28 | 2,200 | 1,900 | NA | 90 | 14,000 | *60* |
| Xylenes, Total | ug/kg | 6.2 U | 6.2 U | 6.2 U | 6.5 U | 6.5 U | 6.3 U | 6.3 U | 7.4 U | 50 U | 180 | NA | 5 U | 1,600 | *200,000* |
| Total Purgeable Hydrocarbons | mg/kg | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 9.1 (TEX) | NA | NA | *200* |
| Total Extractable Hydrocarbons | mg/kg | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | ND | NA | NA | *200* |

*Notes*

U This compound was not detected at or above the associated numerical value (Quantitation limit shown)
ND This compound was not detected
J This concentration for this constituent was an estimated value
B This compound was detected in the lab method blank
NA Not analyzed
(1) Metals were not analyzed for samples from soil borings from supplemental investigations including SB-9, SB-10, SB-11, SB-14, or SB-18.
Shaded values indicate constituent concentrations which exceed the investigation threshold levels

# TABLE 3-2

## Detected Constituent Concentrations for Pre-2001 SWMU 17 Soil Samples
## (Southern Portion of Unit)
## McDonnell Douglas RFI

| CONSTITUENT | UNITS | SAMPLE ID NUMBERS AND RESULTS | | | | | | INVESTIGATION THRESHOLD LEVEL (ITL) |
|---|---|---|---|---|---|---|---|---|
| | | S17B7 | | | S17B8 | | S17B13 | |
| | | (3.5' - 4.5') | (7.5' - 8.5') | (31.5' - 32.5') | (6' - 7') | (11.5' - 12.5') | (9' - 10') | |
| ***Volatile Organics*** | | | | | | | | |
| Acetone | ug/kg | 68 | 35 | 50 | 30 | 25 | 26 U | *16,000* |
| 2-Butanone | ug/kg | 82 | 52 | 49 | 52 | 58 | 26 U | *5,200* |
| cis-1,2-Dichloroethene | ug/kg | 6.6 U | 6.4 U | 6.5 U | 6.3 U | 10 | 19 | *400* |
| trans-1,2-Dichloroethene | ug/kg | 6.6 U | 6.4 U | 6.5 U | 6.3 U | 6.3 U | 3.2 U | *700* |
| Ethylbenzene | ug/kg | 13 | 6.4 U | 6.5 U | 6.3 U | 6.3 U | 6.4 U | *13,000* |
| Methylene chloride | ug/kg | 6.7 | 6.5 | 6.9 | 6.7 | 6.3 U | 20 | *20* |
| Perchloroethene | ug/kg | 4,200 | 9.7 | 7.7 | 12 | 58 | 6.4 U | *60* |
| Toluene | ug/kg | 20 | 6.4 U | 6.5 U | 6.3 U | 6.3 U | 6.4 U | *12,000* |
| 1,1,2-Trichloroethane | ug/kg | 6.6 U | 6.4 U | 6.5 U | 6.3 U | 6.3 U | 6.4 U | *20* |
| Trichloroethene | ug/kg | 44 | 6.4 U | 6.5 U | 6.3 U | 6.3 U | 6.4 U | *60* |
| Xylenes, Total | ug/kg | 6.6 U | 6.4 U | 6.5 U | 6.3 U | 6.3 U | 6.4 U | *200,000* |
| Total Purgeable Hydrocarbons | mg/kg | NA | NA | NA | NA | NA | 0.157 | *200* |
| Total Extractable Hydrocarbons | mg/kg | NA | NA | NA | NA | NA | ND | *200* |

*Notes:*

U This compound was not detected at or above the associated numerical value. (Quantitation limit shown.)
ND This compound was not detected.
J This concentration for this constituent was an estimated value.
B This compound was detected in the lab method blank.
NA Not analyzed.

Shaded values indicate constituent concentrations which exceed the investigation threshold levels.

## TABLE 3-3

**Detected Constituent Concentrations for Pre-2001 SWMU 17 Soil Samples**
**(Eastern Portion of Unit)**
**McDonnell Douglas RFI**

| | | SAMPLE ID NUMBERS AND RESULTS | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| CONSTITUENT | UNITS | S17B6 (9.5' - 11') | S17B12 (MW-10S) (10' - 11') | S17B12 (MW-10S) (10' - 11' Dupe) | S17B15 (9' - 10') | S17B16 (9' - 10') | S17B17 (10' - 11') | S17B20 (7' - 8') | S17B20 (15' - 16') | *INVESTIGATION THRESHOLD LEVEL (ITL)* |
| ***Volatile Organics*** | | | | | | | | | | |
| Acetone | ug/kg | 15 | 1300 U | NA | 34 | 39 | 10 U | 100 U | 90 | *16,000* |
| 2-Butanone | ug/kg | NA | 1300 U | NA | ND | ND | 10 U | 100 U | 36 | *5,200* |
| cis-1,2-Dichloroethene | ug/kg | 6.6 U | 310 U | NA | ND | ND | 5 U | 50 U | 5 U | *400* |
| trans-1,2-Dichloroethene | ug/kg | 6.6 U | 310 U | NA | ND | ND | 5 U | 50 U | 5 U | *700* |
| Ethylbenzene | ug/kg | NA | 310 U | NA | ND | ND | 5 U | 50 U | 5 U | *13,000* |
| Methylene chloride | ug/kg | NA | 310 U | NA | 26 | 27 | 8 B | 40 J,B | 8 B | *20* |
| Perchloroethene | ug/kg | 6.6 U | 310 U | NA | ND | ND | 6 B | 50 U | 5 U | *60* |
| Toluene | ug/kg | NA | 310 U | NA | ND | ND | 5 U | 26 J | 5 U | *12,000* |
| 1,1,2-Trichloroethane | ug/kg | NA | 310 U | NA | ND | ND | 5 U | 50 U | 5 U | *20* |
| Trichloroethene | ug/kg | NA | 310 U | NA | ND | ND | 5 U | 50 U | 5 U | *60* |
| Xylenes, Total | ug/kg | 6.6 U | 310 U | NA | ND | ND | 5 U | 50 U | 5 U | *200,000* |
| Benzene Derivatives | ug/kg | NA | 310 U | NA | ND | ND | 5 U | 870 | 34 | *NA* |
| Total Purgeable Hydrocarbons | mg/kg | 25 | 260 (gasoline) | 302 (gasoline) | 0.002 | ND | ND | NA | NA | *200* |
| Total Extractable Hydrocarbons | mg/kg | 450 | 6,360 (diesel #2) | 6,100 (diesel #2) | 470 (diesel) | 10.4 (diesel) | ND | NA | NA | *200* |

*Notes:*

U This compound was not detected at or above the associated numerical value. (Quantitation limit shown.)
ND This compound was not detected.
J This concentration for this constituent was an estimated value.
B This compound was detected in the lab method blank.
NA Not analyzed.

Shaded values indicate constituent concentrations which exceed the investigation threshold levels.

TABLE 3-4

Detected Constituent Concentrations for Pre-2001 SWMU 17 Groundwater Samples
McDonnell Douglas RFI

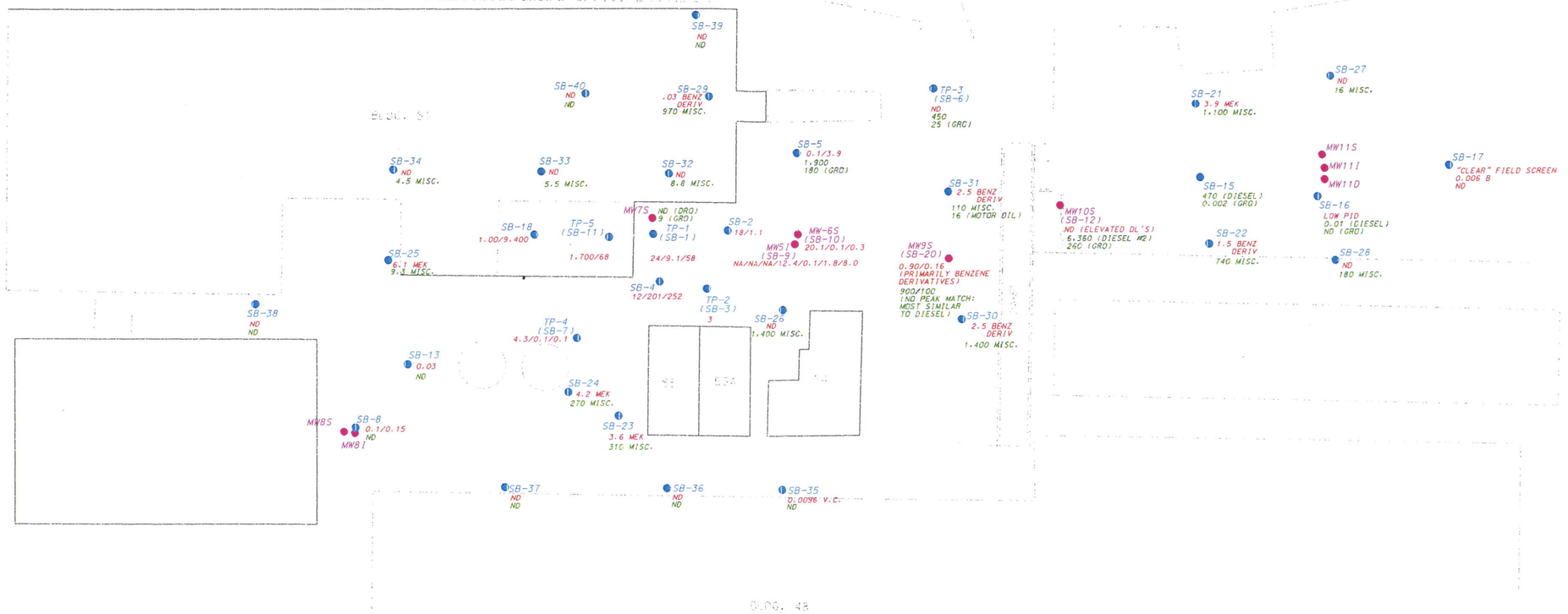
| CONSTITUENT | UNITS | SAMPLE ID NUMBERS AND RESULTS | | | | | | | | | INVESTIGATION THRESHOLD LEVEL (ITL) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | SB-13 (Dec 2000) | TP-4 (April 1998) | TP-4 DUP (April 1998) | SB-18 (Dec 2000) | TP-5 (SB-11) (Dec 2000) | TP-1 (SB-1) (April 1998) | TP-2 (SB-3) (April 1998) | MW-6S (SB-10) (April 1998) | MW-5I (SB-9) (April 1998) | |
| *Volatile Organics* | | | | | | | | | | | |
| Acetone | ug/l | ND | 26 | 24 | ND | ND | 55 | 10 U | 18 | 10 U | *4,000* |
| Benzene | ug/l | ND | 5 U | 5 U | ND | ND | 21 | 5 U | 5 U | 5 U | *5* |
| 1,1-Dichloroethane | ug/l | ND | 5 U | 5 U | ND | ND | 11 | 5 U | 5 U | 5 U | *4,000* |
| 1,1-Dichloroethene | ug/l | ND | 5 U | 5 U | ND | ND | 180 | 15 | 9.3 | 25 | *7* |
| cis-1,2-Dichloroethene | ug/l | 79 | 59 | 58 | 2,400 J | 3,300 | 97,000 | 6,900 | 4,000 | 5,500 | *70* |
| trans-1,2-Dichloroethene | ug/l | 3 | 6.3 | 5.8 | ND | ND | 150 | 30 | 55 | 26 | *100* |
| Ethylbenzene | ug/l | ND | 6.2 | 5.5 | ND | ND | 35 | 5 U | 5 U | 5 U | *700* |
| Methylene chloride | ug/l | ND | 5 U | 5 U | ND | ND | 8.5 | 5 U | 5.5 | 7.5 | *5* |
| Perchloroethene | ug/l | 14 | 17,000 | 11,000 | 86,000 | 54,000 | 210,000 | 45,000 | 5 U | 5 U | *5* |
| Toluene | ug/l | 27 | 36 | 35 | ND | ND | 25000 U | 7.3 | 5 U | 5 U | *1,000* |
| 1,1,2-Trichloroethane | ug/l | ND | 5 U | 5 U | ND | ND | 5 U | 5 U | 5 U | 290 | *5* |
| Trichloroethene | ug/l | 7 J | 150 | 150 | 920 J | 4,600 | 25000 U | 6,000 | 370 | 140,000 | *5* |
| Vinyl chloride | ug/l | ND | 10 U | 10 U | ND | ND | 50000 U | 10 U | 940 | 250 | *2* |
| Xylenes, Total | ug/l | 10 | 17 | 16 | ND | ND | 160 | 5 U | 5 U | 5 U | *10,000* |
| Benzene Derivatives | ug/l | ND | ND | ND | ND | ND | ND | ND | ND | ND | *NA* |
| MTBE | ug/l | NA | NA | NA | ND | ND | NA | NA | NA | NA | *400* |
| Total Purgeable Hydrocarbons | mg/l | NA | ND | ND | NA | NA | ND | ND | ND | ND | *10* |
| Total Extractable Hydrocarbons | mg/l | NA | ND | ND | NA | NA | ND | ND | ND | ND | *10* |

| CONSTITUENT | UNITS | SAMPLE ID NUMBERS AND RESULTS | | | | INVESTIGATION THRESHOLD LEVEL (ITL) |
|---|---|---|---|---|---|---|
| | | TP-3 (April 1998) | SB-20 (MW-9S) (Dec 2000) | SB-12 (MW-10S) (Dec 2000) | SB-17 (Dec 2000) | |
| *Volatile Organics* | | | | | | |
| Acetone | ug/l | 10 U | ND | ND | ND | *4,000* |
| Benzene | ug/l | 5 U | 7 | ND | ND | *5* |
| 1,1-Dichloroethane | ug/l | 5 U | ND | ND | ND | *4,000* |
| 1,1-Dichloroethene | ug/l | 5 U | ND | ND | ND | *7* |
| cis-1,2-Dichloroethene | ug/l | 5 U | ND | ND | ND | *70* |
| trans-1,2-Dichloroethene | ug/l | 5 U | ND | ND | ND | *100* |
| Ethylbenzene | ug/l | 5 U | ND | ND | ND | *700* |
| Methylene chloride | ug/l | 5 U | ND | ND | ND | *5* |
| Perchloroethene | ug/l | 5 U | ND | ND | ND | *5* |
| Toluene | ug/l | 5 U | ND | ND | ND | *1,000* |
| 1,1,2-Trichloroethane | ug/l | 5 U | ND | ND | ND | *5* |
| Trichloroethene | ug/l | 5 U | ND | ND | ND | *5* |
| Vinyl chloride | ug/l | 10 U | ND | ND | ND | *2* |
| Xylenes, Total | ug/l | 5 U | ND | ND | ND | *10,000* |
| Benzene Derivatives | ug/l | NA | 69 | ND | ND | *NA* |
| MTBE | ug/l | 3.2 | ND | NA | ND | *400* |
| Total Purgeable Hydrocarbons | mg/l | 5 | NA | NA | ND | *10* |
| Total Extractable Hydrocarbons | mg/l | 5 | NA | NA | 0.34 (motor oil) | *10* |

*Notes:*

U This compound was not detected at or above the associated numerical value. (Quantitation limit shown.)
ND This compound was not detected.
J This concentration for this constituent was an estimated value.

Shaded values indicate constituent concentrations which exceed the ITLs




SCALE 1"=40'

LEGEND

- MONITORING WELL
- Geoprobe Boring and/or Temporary Piezometer
- 5.4 TOTAL VOCs IN SOIL (mg/kg)
- 450 TPH IN SOIL (mg/kg)

# THE BOEING COMPANY

## Figure 3-1

## VOC and TPH Concentrations in Soil for SWMU No. 17


**Harding ESE**
A MACTEC Company
3199 Riverport Tech Center Drive
St. Louis, MO 63043
314-209-5900


N

W E

SCALE 1"=40'

LEGEND

- MONITORING WELL
- Geoprobe Boring and/or Temporary Piezometer
- 5.4 TOTAL VOCs IN GROUNDWATER mg/l
- 450 TPH IN GROUDWATER (mg/l)

# THE BOEING COMPANY

## Figure 3-2

## VOC and TPH Concentrations in Groundwater for SWMU No. 17

P:/519704.2/DGN/SHEETS/Figure_3-2.dgn 11/26/01

Harding ESE
A MACTEC Company
3199 Riverport Tech Center Drive
St. Louis, MO 63043
314-209-5900

# 4.0 RFI OBJECTIVES AND SUPPORTING DATA REQUIREMENTS

This section describes the objectives of the RFI activities. Specifically, it reviews the objectives of the RFI, identifies data needed to meet these objectives, and describes the overall approach that was followed to obtain these data. An overview and justification of the RFI approach are also provided, as well as a discussion of the role of investigation threshold levels (ITLs) in the project. In addition, this section summarizes specific data quality objectives selected for the RFI.

## 4.1 Project Objectives

Consistent with the terms of the Corrective Action Permit conditions, the RFI is designed to address the following project objectives:

(1) describe the nature and extent of any releases of hazardous waste/constituents from the SWMU No. 17;

(2) gather necessary data to support future Corrective Action requirements (if necessary).

Completion of critical project elements and achievement of the specific RFI objectives requires the identification, collection, and evaluation of site-specific and other local data. The results of the RFI will be utilized in developing appropriate preliminary soil and groundwater screening levels, where appropriate, for the Facility.

For site locations and depths where soil or groundwater concentrations exceed the appropriate preliminary screening levels and a risk analysis shows a threat being posed to human health or the environment, MD will pursue the development of applicable Corrective Measures alternatives. For Facility locations and depths where constituent concentrations do not exceed the appropriate preliminary screening levels, MD will remove these locations from further Corrective Action requirements, thereby conserving resources which would otherwise have been expended on unnecessary activities. Such an approach will allow MD to focus its attention and efforts more rapidly and practically on any significant environmental issues instead of perceived ones.

MD believes that the RFI scope, upon completion, will adequately characterize releases of hazardous waste/constituents as required by the Part B Permit and will achieve the objectives outlined above. Any supplemental investigation activities will be designed to satisfy delineation criteria and provide data necessary for development of alternatives under a Corrective Measures Study (CMS).

## 4.2 Data Needs and Usage

An investigation to delineate the nature and extent of any releases at the Facility requires various types and amounts of information. Specific investigation approaches, methodologies, and data are required to facilitate the investigation process. This section of the document summarizes the general strategy presented in the RFI Workplan for collection of the data needed to achieve the investigation objectives at the Facility.

Based on a review of previous investigation results and an evaluation of site-wide conditions, sampling plans were prepared to delineate the nature and extent of any releases. Soil and groundwater sampling locations were selected in and around SWMU No. 17 at locations where constituents of concern were most likely to be found based on historical knowledge, prior investigation results, hazardous wastes/constituents managed at the unit, and field screening criteria (visual observations and portable instrument screening). In accordance with the approved RFI Workplan Addendum and Workplan Addendum II, selected samples were collected and submitted for laboratory analyses.

In addition, groundwater monitoring activities were conducted at SWMU No. 17 to determine groundwater flow direction and gradients. Monitoring results were used to evaluate potential migration of any impacted groundwater at this unit.

## 4.3 Data Quality Objectives

The intended use of the various data types was evaluated to establish appropriate data quality objectives. A summary of this evaluation is provided below.

As described in the MDNR-approved RFI Workplan, the following DQO levels were deemed appropriate:

1) DQO Level I was deemed appropriate to conduct screening and acquire data for basic site characterization, e.g. pH, temperature, specific conductance, water level elevations, physical descriptions, PID readings, and other similar geologic/hydrogeologic information. Specifically, the data acquired under DQO Level I were used to:

- detect changes in groundwater characteristics;
- develop groundwater elevation contour maps and evaluate groundwater flow gradients;
- describe basic physical properties of investigated media; and
- verify adequate purging of monitoring wells.

2) DQO Level III was deemed appropriate for soil and groundwater sample analyses. The data acquired under DQO Level III was used to characterize constituent concentrations in various media and delineate the nature/extent of any releases of hazardous wastes/constituents. These data may also be used to determine soil/groundwater clean-up objectives, support a risk assessment, and support engineering evaluations necessary to select and design Corrective Measures, if required.

## 4.4 Investigation Threshold Levels (ITLs)

Investigation threshold levels (ITLs) are commonly developed and used at both Corrective Action and CERCLA sites to determine whether field investigations should proceed beyond an initial phase. In fact, this concept is inherent to both the proposed RCRA Subpart S rule (as well as other proposed rulemakings) and guidance being developed and implemented under the Corrective Action and Superfund programs. MD believes that such a concept is appropriate for the Facility and has developed conservative values against which the RFI data have been evaluated.

This section identifies these conservative values (ITLs) that have been used to determine the need for further investigation or to recommend no further action. ITLs were utilized as a comparative baseline for SWMU-specific analytical results, e.g. to determine whether a release to soil has been delineated or assess whether groundwater impacts are present. These ITLs are being used to focus the risk assessment process on the relevant constituents of concern.

For the purposes of the RFI, ITLs represent values which incorporate both risk-based action levels and site-specific background levels. As a result, the comparative process for analytical results is simplified.

ITLs were derived for soils from USEPA Soil Screening Levels (SSLs), as of July 1996. For instances where the SSLs values were unavailable, alternative USEPA Region 5 Data Quality Levels (DQLs), Region 9 Preliminary Remediation Goal (PRGs), or Tier 1 levels specified in Cleanup Levels for Missouri (CALM) were used. ITLs for groundwater were derived in a similar manner using non-zero MCLGs, MCLs, or HBLs derived for the SSLs. For instances where the SSL-based criteria were unavailable, alternative USEPA Region 5 DQLs, Region 9 PRG values, or relevant CALM-based standards were used.

Soil and groundwater ITLs are presented in Tables 4-1 and 4-2, respectively, for the constituents detected in the RFI. These tables also include the relevant SSL-based criteria and alternative risk-based reference values (e.g. DQLs, PRGs, CALM), as appropriate.

## Table 4-1
## Determination of Investigation Threshold Levels (ITLs) for Soils (values in ug/kg)
## RCRA Facility Investigation
## McDonnell Douglas Facility
## Hazelwood, Missouri

| Constituent | MD Investigation Threshold Level (ITL) for Soil (1) | CERCLA Soil Screening Levels (SSLs) (2) | EPA Region V Data Quality Levels (3) | EPA Region IX Preliminary Remediation Goals (4) | Missouri CALM Residential Scenario A (5) |
|---|---|---|---|---|---|
| **VOLATILE ORGANIC COMPOUNDS (VOCs)** | | | | | |
| Acetone | 16,000 | 16,000 | 9,200,000 | -- | -- |
| Benzene | 30 | 30 | 2,700 | -- | -- |
| 2-Butanone | 5,200 | -- | 5,200 | 4,200,000 | -- |
| 1,1-Dichloroethane | 23,000 | 23,000 | 400,000 | -- | -- |
| 1,1-Dichloroethene | 60 | 60 | 70 | -- | -- |
| cis-1,2-Dichloroethene | 400 | 400 | -- | -- | -- |
| trans-1,2-Dichloroethene | 700 | 700 | -- | -- | -- |
| Ethylbenzene | 13,000 | 13,000 | 58,000 | -- | -- |
| Methylene chloride | 20 | 20 | 22,000 | -- | -- |
| Tetrachloroethene | 60 | 60 | 22,000 | -- | -- |
| Toluene | 12,000 | 12,000 | 280,000 | -- | -- |
| 1,1,1-Trichloroethane | 2,000 | 2,000 | 280,000 | -- | -- |
| 1,1,2-Trichloroethane | 20 | 20 | -- | -- | -- |
| Trichloroethene | 60 | 60 | 7 | -- | -- |
| Vinyl Chloride | 10 | 10 | -- | -- | -- |
| Xylenes, Total | 200,000 | 200,000 | 99,000 | -- | -- |
| Gasoline Range Organics | 200,000 | -- | -- | -- | 200,000 |
| Total Extractable Hydrocarbons | 200,000 | -- | -- | -- | 200,000 |

Listed constituents were detected in the RFI.
-- Applicable value not available.

**Footnotes:**

1 Investigation Threshold Levels (ITLs) for soils were primarily derived from USEPA Soil Screening Levels (July 1996). For instances where the SSLs or background values were unavailable, alternative USEPA Region V Data Quality Levels, Region IX Preliminary Remediation Goal (PRG) values were used as referenced below. USGS Regional Background concentrations for metals.

2 Soil Screening Levels, July 1996. Value represents most conservative of 3 exposure pathways including ingestion, inhalation and migration to groundwater (DAF of 20).

3 Alternative value acquired from USEPA Region V Data Quality Levels, December 1995.

4 Alternative value acquired from EPA Region IX Preliminary Remediation Goals, August 1, 1996.
- Levels for migration to groundwater (GW) pathway based on dilution and attenuation factor of 10
- Levels for metals based on a pH = 8.0

5 Cleanup Levels for Missouri, September 2001. Value represents most conservative of 3 exposure pathways (Residential or Scenario "A").

## Table 4-2
## Determination of Investigation Threshold Levels (ITLs) for Groundwater (ug/l)
## RCRA Facility Investigation
## McDonnell Douglas Facility
## Hazelwood, Missouri

| Constituent | MD Investigation Threshold Level (ITL) for Groundwater (1) | CERCLA Soil Screening Levels (SSLs) (2) | EPA Region V Data Quality Levels (3) | EPA Region IX Preliminary Remediation Goals (4) | Missouri CALM GTARC Concentrations (5) |
|---|---|---|---|---|---|
| **VOLATILE ORGANIC COMPOUNDS (VOCs) (ug/l)** | | | | | |
| Acetone | 4,000 | 4,000 | 9,200,000 | -- | -- |
| Benzene | 5 | 5 | 2,700 | -- | -- |
| 2-Butanone (MEK) | 1,900 | -- | 5,200 | 1,900 | -- |
| 1,1-Dichloroethane | 4,000 | 4,000 | 400,000 | -- | -- |
| 1,1-Dichloroethene | 7 | 7 | -- | -- | -- |
| cis-1,2-Dichloroethene | 70 | 70 | -- | -- | -- |
| trans-1,2-Dichloroethene | 100 | 100 | -- | -- | -- |
| Ethylbenzene | 700 | 700 | 58,000 | -- | -- |
| Methylene chloride | 5 | 5 | 22,000 | -- | -- |
| Tetrachloroethene | 5 | 5 | 22,000 | -- | -- |
| Toluene | 1,000 | 1,000 | 280,000 | -- | -- |
| Trichloroethene | 5 | 5 | 7 | -- | -- |
| 1,1,2-Trichloroethane | 5 | 5 | -- | -- | -- |
| Vinyl chloride | 2 | 2 | -- | -- | -- |
| Xylenes, Total | 10,000 | 10,000 | 99,000 | -- | -- |
| Gasoline Range Organics | 10,000 | -- | -- | -- | 10,000 |
| Total Extractable Hydrocarbons | 10,000 | -- | -- | -- | 10,000 |

Listed constituents were detected in the RFI.
-- Applicable value not available.

**Footnotes:**
1 Investigation Threshold Levels (ITLs) for groundwater were primarily derived from USEPA Soil Screening Levels (SSLs). For instances where the SSLs were unavailable, alternative USEPA Region V Data Quality Levels or Region IX Preliminary Remediation Goal (PRG) values were used as referenced below.
2 Soil Screening Levels, July 1996, non-zero MCLG, MCL, or HBL.
3 Alternative value acquired from USEPA Region V Data Quality Levels, December 1995.
4 Alternative value acquired from EPA Region IX Preliminary Remediation Goals, August 1, 1996.
5 Cleanup Levels for Missouri, September 2001. Value represents groundwater target concentration (GTARC).

# 5.0 2001 FIELD ACTIVITIES

This section summarizes the 2001 (December 2000 thru December 2001) field activities which were conducted to further define the nature and extent of hazardous waste/constituent releases at SWMU No. 17. These activities included: soil boring installations, soil sampling and analyses, temporary piezometer/monitoring well completion, and groundwater monitoring and analyses. Field activities were completed for both soil and groundwater evaluation purposes.

The following general chronology of field activities was completed to fulfill the RFI scope of work as outlined in the RFI Workplan and associated Workplan Addenda:

1) Installation of ten (10) investigative soil borings in December 2000 to assess geological and hydrogeological conditions beneath SWMU No. 17;
2) Installation of eight (8) groundwater monitoring wells in December 2000 to assess hydrogeological conditions beneath SWMU No. 17;
3) Installation of twenty (20) soil borings/temporary piezometers (TP-6 thru TP-25) in September and October 2001 to assess geological/hydrogeological conditions beneath SWMU No. 17;
4) Sampling of subsurface soils utilizing continuous and discrete interval split spoon collection methods;
5) Collection of subsurface soil samples for field screening and laboratory analyses;
6) Collection of groundwater samples for field screening and laboratory analyses;
7) Monitoring of groundwater elevation surface.

All field activities were conducted in accordance with the protocols described in the QAPP and the HASP.

## 5.1 Installation of Soil Borings

Soil borings were installed at various locations to evaluate the nature and extent of any hazardous waste or hazardous constituent releases to soils at SWMU No. 17. The soil boring activities were also completed to further evaluate the geological and hydrogeological systems at this unit.

Under the supervision of Harding ESE field personnel, drilling activities were conducted by Roberts Environmental Drilling, Inc. (Roberts Environmental Drilling). Site-specific activities were completed using a Bobcat-mounted Geoprobe hydraulic rig and a truck-mounted CME 75 drilling rig.

Soil borings were installed using standard direct push soil probe and hollow-stem auger (HSA) drilling methodologies. Direct push soil borings completed with the Geoprobe rig were advanced using a 2.0-inch outside diameter (OD) macro-core sampler and 1.25-inch OD steel probing rods. Soil borings completed with the CME 75 drilling rig were advanced using 4.25-inch internal diameter hollow-stem augers and a 2.5-inch ID CME continuous soil sampler.

Prior to drilling at the initial and all subsequent borings, ancillary rig equipment were cleaned to eliminate cross-contamination between successive drilling locations. The Geoprobe-related sampling tubes were cleaned between SWMUs and detergent washed between sampling locations.

Continuous soil samples were collected from each boring for field screening, lithographic description, and subsequent chemical analysis. Each disposable sampling tube liner (or CME sampler) was opened and immediately scanned with a PID to identify potential presence of VOCs. To maintain lithographic descriptive consistency, each soil sample was described and classified in accordance with the Unified Soil Classification (USC) system.

Upon completion of drilling and groundwater sampling, each Geoprobe boring was abandoned by grouting with bentonite chips to the surface. Each boring was sealed at the surface with concrete or asphalt. Portable roll-off containers were used to accumulate soil cuttings for subsequent transfer into larger roll-off units and management by Boeing.

RFI field activities were completed in accordance with the guidelines specified in the RFI Workplan and subsequent Workplan Addenda. A biased sampling approach was used to locate soil sampling locations at SWMU No. 17. The approximate locations, number of samples, and analyses were determined using the following criteria:

- guidelines specified in the RFI Workplan and Workplan Addenda;
- historic operations performed at a specified area;
- soil boring and analytical results from prior site investigations;
- hazardous wastes or hazardous constituents managed; and
- field conditions (e.g. staining, PID readings, obstructions, etc.).

## 5.2 Soil Sampling and Analysis

Soil samples were collected from each boring to evaluate the nature and extent of any hazardous waste or hazardous constituent releases to soils at SWMU No. 17. Soil sampling activities were also completed to further evaluate the geological and hydrogeological systems beneath the unit. Continuous split spoon soil samples were collected from selected borings for field screening, lithographic description, and subsequent chemical analysis.

Each soil sample was screened in the field with a PID for total organic vapors by the headspace method. This process involved placing a portion of the soil sample into a resealable plastic bag and allowing time for volatilization, if any, to occur. The PID probe was then inserted into the plastic bag. The highest PID reading measured for the initial 10-second period was recorded on the boring log form in units of parts per million (ppm).

All field screening equipment was calibrated at a minimum of once per day during RFI field efforts. Instrument calibration was performed in accordance with the manufacturers' recommended procedures using commercially available calibration standards. Calibration data were recorded in field notebooks.

Selected soil samples collected during the RFI field activities were submitted for laboratory analysis. Samples were collected per the specifications in the MDNR-approved RFI Workplan and subsequent Workplan Addenda.

Duplicate and trip blank samples were collected and analyzed in accordance with the QAPP specifications. The soil duplicate samples were analyzed for SWMU-specific parameters. Trip blank samples were analyzed for VOCs only.

Upon collection, each soil sample was managed according to the procedures described below. These procedures were established in accordance with the QAPP. Appropriate USEPA analytical methods, sample preservation techniques, sample volumes, and holding times are also presented in the QAPP.

Samples were collected into sample containers which were pre-cleaned and assembled to USEPA's Protocol "B". The volume of sample collected and the type of container used was determined by the suggested volumes described in SW-846 for the particular analysis. A summary of the bottle requirements and sample volumes is included in the QAPP.

Immediately upon collection, each sample was properly labeled to prevent misidentification. The sample labels were made of waterproof material and filled out with waterproof ink. The sample labels included the sample number, sample location, sample depth, date sampled, time sampled, analyses to be performed, and sample collector's name.

After labeling, the samples were placed into an appropriate shipping container. Samples collected for organic analysis were placed into a shipping container with sufficient ice or ice packs to preserve samples during transport to the laboratory. The samples were appropriately packaged in the storage container to minimize the potential for damage during shipment. A completed chain-of-custody form was placed in each storage container to accompany the samples to the laboratory.

The sample containers were shipped via overnight courier to Environmental Science Corporation (ESC) labs in Mount Juliet, Tennessee. Samples were shipped so that the laboratory received the samples within 24 hours from the time of shipment. Strict chain-of-custody procedures were maintained during sample handling.

A chain-of-custody program was followed to track the possession and handling of individual samples from time of collection through completion of laboratory analysis. Copies of the chain-of-custody record were retained in the permanent file for proper documentation. The chain-of-custody forms included:

- Sample number
- Date and time of collection
- Sample type (e.g., soil, groundwater, etc.)
- Number of containers
- Parameters requested for analysis
- Signature of person(s) involved in the chain of possession
- Inclusive dates of possession

Soil sampling was performed to 1) delineate the horizontal and vertical extent of any potential releases at SWMU No. 17 and 2) define the geological and hydrogeological systems beneath the unit. Subsequent soil analyses were conducted to provide a quantitative evaluation of constituent impacts to soil at SWMU No. 17.

Soil samples were analyzed for SWMU-specific parameters in accordance with the guidelines specified in the RFI Workplan and Workplan Addenda. Laboratory analyses were conducted in accordance with appropriate USEPA methodologies as prescribed in the QAPP. Analytical results for the soil samples are provided in Section 6.0.

## 5.3 Installation of Temporary Piezometers and Monitoring Wells

A total of thirty (30) temporary piezometers and ten (10) monitoring wells have been installed to facilitate characterization of groundwater conditions beneath SWMU No. 17. Four (4) temporary piezometers and two (2) monitoring wells (MW-5I, MW-6S) were completed during the 1998 activities. As part of the 2000 field activities, six (6) temporary piezometers and eight (8) monitoring wells (MW-7S, MW-8S, MW-8I, MW-9S, MW-10S, MW-11S, MW-11I, and MW-11D) were completed. As part of the 2001 field activities, twenty (20) temporary piezometers were completed. The piezometer and monitoring well locations/elevations were surveyed.

Under the supervision of Harding ESE field personnel, temporary piezometer and monitoring well installation activities were completed by Roberts Environmental Drilling. Temporary piezometers and monitoring wells installed within the shallow groundwater unit (generally 5-16 ft bls) in accordance with the RFI Workplan, Workplan Addenda, and the following general protocols:

1) Prior to installation of each piezometer/monitoring well, each screen and riser pipe were inspected to ensure that no oils, greases, waxes, or other contaminants were present.
2) Each temporary piezometer was constructed of 1-inch diameter, PVC with flush-threaded joints. Five-foot screen sections were utilized at the bottom of each installation.
3) Each monitoring well was similarly was constructed of 2-inch diameter, PVC with flush-threaded joints. Ten (10) feet sections of 0.010 slot well screen were utilized at the bottom of most shallow monitoring well installations. MW-5I, MW-8S, MW-8I, and MW-11I were installed with an 8-ft screen, while MW-7S was constructed of 4-inch diameter stainless steel and utilized 12 ft of stainless steel wire wrap well screen.
4) The artificial sand pack consisted of chemically inert, rounded, silica sand and was placed to a height of approximately 2 feet above the top of the screen.
5) A bentonite chip seal (2-ft minimum thickness) was placed above the sand pack material.
6) The annular space above the bentonite seal was sealed with cement/bentonite grout by the tremie method.
7) Each monitoring well was completed with a flush-mounted water-tight protective casing.
8) Well construction details were recorded on standard field forms.

Special installation procedures were utilized for MW-8I, MW-11I, and MW-11D to ensure that cross-contamination did not occur between the shallow and deep water-bearing units. These wells were constructed using 10-1/4" I.D. hollow stem augers to set a 10-inch casing. The intermediate casings were constructed of PVC and set at an approximate depth of 26.5 ft bls. The casing for the deep well (MW-11D) was constructed of 10-inch steel and set at an approximate depth of 50 ft bls. The open boring was filled with a high early strength cement grout. The bottom of the casing was sealed with a PVC endcap and the casing was floated/centered in the boring, assuring a complete seal around the casing. To enable the casing to sink into the grout-filled boring, the casing was filled with potable water. After the cement had set, the casing was pumped out and the boring was advanced through the endcap to total depth using 4-1/4" I.D. hollow stem augers.

## 5.4 Groundwater Monitoring Events

Four groundwater monitoring events were subsequently conducted in 2001 to acquire groundwater quality/elevation data from SWMU No. 17.

Water level measurements were performed using an electronic water level probe and measured to the nearest 1/100 foot. Data were recorded on a standard monitoring form.

Prior to the collection of groundwater samples, each temporary piezometer was purged using a disposable polyethylene bailer or a peristaltic pump using dedicated polyethylene tubing. Temporary piezometers that were placed in open boreholes and sampled within 24 hours of installation were purged of a minimum of one casing volume of groundwater. Temporary piezometers that were installed with sandpack, seal, and surface completions were purged using the same procedures as for monitoring wells (i.e. 3 casing volumes or until dry). Samples were then collected using a disposable polyethylene bottom-loading bailer or peristaltic pump using appropriate collection procedures as specified in the RFI Workplan and the Workplan Addenda.

Shallow groundwater monitoring wells were purged using a disposable polyethylene bailer or a peristaltic pump with disposable polyethylene tubing. Each shallow well was purged by removing a minimum of three well volumes and obtaining stabilized field parameter readings, or until the well bailed dry. Samples were then collected using a disposable polyethylene bottom-loading bailer and using appropriate collection procedures as specified in the RFI Workplan and the Workplan Addenda.

The intermediate and deep zone wells were equipped with dedicated bladder pumps and tubing during the first quarter of 2001. A low flow sampling methodology following EPA Region 1 Low Stress (Low Flow) Purging and Sampling Procedures was attempted on the intermediate and deep zone wells during 2001, along with shallow wells that were purged with a peristaltic pump to allow for the measurement of bioremediation parameters (USEPA, 1996). In summary, the low flow methodology consists of purging groundwater at a rate that prevents the drawdown of the well and such that the total drawdown of the well does not exceed 0.3 ft until measured groundwater parameters stabilize. The purge rate must be over 30 ml/min.

More specifically, temperature, pH, dissolved oxygen (DO), conductivity, and redox potential (ORP) are measured from the purge water at 3-5 minute intervals using appropriate calibrated meters installed in a flow-through cell. Sampling occurs after 3 successive water level measurements have stabilized and the following criteria have been met:

- Temperature within 3%;
- pH within 0.1 unit;

- Specific conductivity within 3%;
- DO within 10%; and
- ORP within 10 millivolts.

Although purge volume is not of concern in the low stress (low flow) sampling procedure, a minimum volume at or greater than the total volume of the pump and hose was purged to remove the trapped (stagnant) water in the pump and discharge line.

Based on the quarterly groundwater monitoring results for 2001, only wells MW-11D and MW-7S produce enough water from the formation to meet the low flow sampling criteria. The intermediate and other shallow wells did not produce at a rate over 30 ml/min without drawing down the groundwater level in the well.

Duplicate and trip blank samples were collected and analyzed in accordance with the QAPP specifications. The duplicate samples were analyzed for SWMU-specific parameters. Trip blank samples were analyzed for VOCs only.

Upon collection, each groundwater sample was managed in accordance with QAPP-specified protocols. Appropriate USEPA analytical methods, sample preservation techniques, sample volumes, and holding times are also presented in the QAPP. Each sample was collected and placed in an appropriate sample container and submitted for laboratory analysis.

Groundwater samples were analyzed for SWMU-specific VOCs and TPH as specified in the RFI Workplan and Workplan Addenda. Laboratory analyses were conducted in accordance with appropriate USEPA methodologies as prescribed in the QAPP.

## 5.5 Aquifer Test Procedures

Two short-term pump tests were performed to evaluate various hydrogeological properties (hydraulic conductivity, transmissivity, and hydraulic interconnection) of the shallow saturated unit within the source area. These data were used with gradient information to determine groundwater flow velocities.

The pump tests were conducted using a peristaltic pump to extract groundwater from MW-7S. The pumping rate was checked every 10-15 minutes and adjusted to maintain a constant flowrate. Drawdown was measured in the pumping well (MW-7S) and in seven surrounding piezometers/wells (TP-1, TP-2, TP-5, TP-14, TP-17, MW-5I, and MW-6S) with eight 20-psi pressure transducers linked to a Hermit 3000 datalogger. A laptop computer with specifically designed software was used to

communicate and download data from the Hermit 3000. Drawdown data was acquired from the datalogger and imported into a spreadsheet program that was used to graph the data. Hydrogeological parameters were subsequently calculated for the shallow water-bearing unit.

The pump tests were conducted on November 1 and 2, 2001. On November 1, 2001, initial water levels in the wells/piezometers were measured. At that time, several wells were found to be pressurized (e.g. water levels inside these wells rose as the well equilibrated with atmospheric pressure). As a result, the wells were opened and allowed to equilibrate for a 4-hour period while setup for the pump test was performed. Monitoring well MW-5I was the most pressurized well location (e.g. the initial water level was 11.70 feet below the top of the well casing (TOC) and 7.07 ft below TOC at the beginning of the pump test). The pressurized condition observed in the wells resulted from the sealed wells not equilibrating from the groundwater sampling event approximately 6 days prior to the pump test.

The initial pump test was conducted for a 4-hour period. During the test, water levels continued to rise in MW-5I, MW-6S, and TP-2. The pumping test rate of 1,000 milliliters per minute (ml/min) resulted in a drawdown of approximately 1.5 feet in MW-7S by the end of the test. At the end of the 4-hour pumping period, the transducers were removed from MW-5I, MW-6S, and TP-2 overnight to protect the equipment from vehicle traffic during the night. Groundwater recovery was recorded with the datalogger in the remaining piezometers and the pumping well for a 15-hour period. A graph of the drawdown and recovery data for this test is provided in Appendix C.

The second pump test was conducted on November 2, 2001 with an increased pumping rate over a longer duration. The pumping portion of the test was conducted for a 7-hour period; recovery data was collected for a subsequent 1-hour period. A pumping rate of approximately 1,300 ml/min (maximum rate of the pump) was used for the initial 3 hours of the test. At that time, the peristaltic pump overheated and the flowrate was reduced to approximately 1,100 ml/min for the duration of the test. A graph of the drawdown and recovery data for this test is also provided in Appendix C.

Water removed from the well was pumped into a 500-gallon tank for temporary storage purposes. Following completion of the pump test, the water was sampled, transferred to 55-gallon drums, and properly disposed by Boeing.

# 6.0 2001 RESULTS

This section discusses the geological soil boring data, analytical soil data, analytical groundwater data, groundwater elevation measurements, and various field data from the 2001 monitoring period which were utilized to further characterize the nature and extent of any hazardous waste/constituent impacts from SWMU No. 17.

Section 6.1 summarizes the geological and hydrogeological results acquired from the RFI. Copies of the soil boring and temporary piezometer/monitoring well logs are provided in Appendix A.

Sections 6.2 - 6.5 present the results of the 2001 investigation activities at SWMU No. 17. Applicable soil and/or groundwater analytical concentrations were compared with ITLs to characterize the nature and delineate the extent of any potential releases at the unit. Analytical laboratory data were assessed and validated based upon a review of standard quality control criteria established by the QAPP. Copies of the analytical reports and data validation summaries are provided in Appendix B.

## 6.1 Geological and Hydrogeological Results

Geological and hydrogeological information was acquired through an evaluation of the soil boring logs, associated geological cross-sections, geotechnical analyses, pump test results, and groundwater elevation measurements that were conducted at the Facility. Results are summarized below.

### 6.1.1 Geological Results

Soil boring data acquired during various 2001 investigations indicate the presence of four general soil stratigraphic units overlying the bedrock surface at the Facility. These four general units are defined in descending order as the 1) Fill Unit, 2) Silty Clay Unit, 3) Silt Unit, and 4) Clay Unit.

Fill Unit

Soil boring data indicate that a heterogeneous Fill Unit overlies the native materials at the Facility. Fill generally consisted of a mixture of materials either excavated at the site or brought in as clean fill during Facility construction/modification activities. Categories specifically encountered include: 1) clay, gravel, and asphalt mixture, and 2) isolated construction debris including blocks of concrete, brick, and rubble. Buildings and concrete/asphalt pavement overly the Fill Unit at SWMU No. 17.

Silty Clay Unit

Soil boring data indicate the presence of a Silty Clay Unit beneath the surface or the previously defined unit. These native materials generally consisted of gray-brown to red-brown, soft to stiff,

silty clay. Unit thickness generally ranged from 8-12 ft. Shallow groundwater was encountered within the Silty Clay Unit, perched on the underlying units. Groundwater at SWMU No. 17 was detected from 2-8 ft bls.

Silt Unit

Soil boring data indicate the presence of a Silt Unit underlying the Silty Clay Unit. The native materials appear to be Lacustrine (lake-formed) in origin and are very thinly bedded with abundant organic debris (wood fragments and twigs). The silt is dark reddish-brown, medium stiff, and slightly moist. Unit thickness was generally between 1-3 feet. Due to the low moisture content of the silt and the presence of perched groundwater in the overlying Silty Clay Unit, the Silt Unit and underlying Clay Unit appear to act as an aquitard.

Clay Unit

Soil boring data from the deep groundwater monitoring wells indicate the presence of a Clay Unit underlying the Silt Unit. These native materials generally consisted of light to dark gray, stiff to very stiff, plastic clay. This unit was generally encountered between 15-20 ft bls and extended to a depth of approximately 75 ft bls. Within 8-10 ft above the top of the bedrock surface, the Clay Unit contained weathered shale intermixed in the clay matrix.

Based on interpretations from the site-specific RFI boring results, previous investigations, and regional geological information, the Silt Unit and the Clay Unit are expected to be relatively uniform and continuous beneath the Facility and immediately surrounding area. As such, the units serve as an aquitard beneath the Facility, effectively limiting any vertical migration of groundwater.

### 6.1.2 Hydrogeological Results

Vertical Hydraulic Conductivity

Geotechnical lab results for vertical hydraulic conductivity ranged from $7.1 \times 10^{-6}$ cm/sec for a sample collected from 9-11 ft bls in MW-11S (Silty Clay Unit) to $1.1 \times 10^{-9}$ cm/sec for a sample collected from 59-60 ft bls in MW-11D (Clay Unit). These lab results indicate that vertical hydraulic conductivity decreases with depth. A copy of the geotechnical lab results is provided in Appendix C.

Pump Test Results

Pump test results were used to determine other various hydrogeological parameters including transmissivity and horizontal hydraulic conductivity of the shallow water-bearing unit. At SWMU No. 17, the saturated thickness was estimated to be 17.23 feet (distance from the top of the silt layer to the top of the static water level in MW-7S before starting the pump test). The drawdown data were graphed and analyzed using the Neuman method (Neuman, 1975).

Because of unequilibrated water levels and short test duration, only pumping well (MW-7S) data from the November 1, 2001 pump test were evaluated. Data acquired during the November 2, 2001 pump test from the pumping well (MW-7S) and piezometers TP-1, TP-5, and TP-17 displayed sufficient drawdown for analysis. Copies of the associated graphs, equations, and sample calculations are provided in Appendix D.

Transmissivity

Transmissivity is defined as a measure of the capacity for a porous medium to transmit water through the thickness of the media. For an unconfined aquifer, the media thickness is the saturated thickness of the aquifer or the height of the water table above the top of the underlying aquitard that bounds the aquifer (Freeze and Cheery, 1979). The units for transmissivity are length squared per time.

Calculated transmissivity values are provided below:

- 10.91 $ft^2$/day (1.17 x $10^{-1}$ $cm^2$/sec) for MW-7S based on the first pump test;
- 11.78 $ft^2$/day (0.127 x $10^{-1}$ $cm^2$/sec) for MW-7S based on the second pump test;
- 1.77 $ft^2$/day (1.90 x $10^{-2}$ cm/sec) for TP-5;
- 4.30 $ft^2$/day (4.62 x $10^{-2}$ cm/sec) for TP-17; and
- 0.45 $ft^2$/day (4.89 x $10^{-3}$ cm/sec) for TP-1.

Horizontal Hydraulic Conductivity

Horizontal hydraulic conductivity is the transmissivity divided by the thickness of the aquifer. The units for hydraulic conductivity are length per time.

Calculated horizontal hydraulic conductivity values are provided below:

- 0.63 ft/day (2.21 x $10^{-4}$ cm/sec) for MW-7S based on the first pump test;
- 0.68 ft/day (2.39 x $10^{-4}$ cm/sec) for MW-7S based on the second pump test;
- 0.10 ft/day (3.62 x $10^{-5}$ cm/ sec) for TP-5;
- 0.25 ft/day (8.80 x $10^{-5}$ cm/ sec) for TP-17; and
- 0.03 ft/day (9.32 x $10^{-6}$ cm/sec) for TP-1.

The hydraulic conductivity of 2.4 x $10^{-4}$ cm/sec for MW-7S is consistent with the reported range of values for a silty sand or silt. The hydraulic conductivity range of 8.8 x $10^{-5}$ to 9.3 x $10^{-6}$ cm/sec for the piezometers is consistent with the reported range of values for a glacial till (Freeze and Cherry, 1979).

Given the lateral extent of constituents detected in the groundwater and low flow characteristics observed in all of the shallow monitoring wells except MW-7S, the overall hydraulic conductivity for the site is estimated as closer to the values reported for glacial till of 1 x $10^{-5}$ - 1 x $10^{-6}$ cm/sec.

Linear Groundwater Velocity

Linear groundwater velocity is defined as the ratio of travel distance to travel time. It can be expressed by the following equation:

$$V = Ki / n$$

where: V = linear (horizontal) groundwater velocity; K = hydraulic conductivity; I = horizontal hydraulic gradient; and n = effective porosity.

Effective porosity (also known as specific yield in unconfined flow systems) is a measure of the system's ability to release water from voids between the individual soil grains. The effective porosity of clay is generally between 0 - 10 percent (Driscoll, 1986). This is due to soil surface retention of water and dead-end pore space. Because the shallow water-bearing unit consists of silty clay, an effective porosity value of 10 percent was used in the calculation of groundwater velocity.

Substituting the horizontal hydraulic conductivity estimates for MW-7S and average horizontal hydraulic gradient for 2001 (calculated using the groundwater elevation data) into the linear velocity equation yields the following groundwater velocity values:

- 0.099 ft/day (36.14 ft/yr) between MW-7S and MW-11S; and
- 0.171 ft/day (62.42 ft/yr) between MW-7S and MW-8S.

Substituting the hydraulic conductivity estimates for TP-1 into the same equation yields the following groundwater velocity values:

- 0.004 ft/day (1.46 ft/yr) between MW-7S and MW-11S; and
- 0.008 ft/day (2.92 ft/yr) between MW-7S and MW-8S.

### 6.1.3 Geological Cross-Section for SWMU No. 17

Based on the available RFI soil boring data for SWMU No. 17, a geological cross-section was prepared to illustrate subsurface characteristics at this unit. The cross-section depicts the relationships between various geologic units. The location of the cross-section is indicated in Figure 6-1. Geological cross-section A-A' (southwest-northeast) for SWMU No. 17 is presented as Figure 6-2.

Geological/Hydrogeological Interpretations

The following conclusions were based from a review of the cross-section:

- The Fill Unit beneath SWMU No. 17 extends from at/near the surface to a depth of approximately 2-5 ft bls.
- The Silty Clay Unit is encountered beneath the Fill Unit and exhibits a typical thickness of approximately 12-15 ft.;
- The Clay Unit is encountered at approximately 17 ft bls;

- SWMU No. 17 is underlain by an apparently continuous, homogeneous lacustrine clay of undetermined total thickness; and
- Present across the Facility and including SWMU No. 17, the continuity and thickness of the Clay Unit are verified. The low vertical permeability of this Clay Unit provides a degree of vertical hydraulic separation from the underlying bedrock.

## 6.2 Analytical Results for SWMU No. 17 Soil Samples

Analytical results for SWMU No. 17 soil samples collected in 2001 were utilized to further assess the horizontal and vertical extent of any impacted soils at this unit.

Twenty three (23) total borings were advanced to further assess the extent of any releases from SWMU No. 17. Several of the soil borings exhibited PID/visual evidence of TPH-related impacts, thus necessitating the completion of additional "step-out" borings. At these locations, the impacted boring was plugged and a new boring was advanced at a location of 20-30 ft further away from the source area. In this manner, the horizontal extent of SWMU No. 17 was more accurately delineated.

Soil samples were collected from each of the borings and submitted for chemical analysis to delineate the horizontal extent of SWMU No. 17. Boring locations and associated analytical results are displayed in Figure 6-3. Analytical results for constituents detected in soil samples from the western, southern, and eastern portions of the unit are summarized in Tables 6-1, 6-2, and 6-3, respectively.

Three (3) VOC constituents including 2-butanone, various TPH-related benzene derivatives, and vinyl chloride were detected in samples acquired from this area. The highest VOC concentrations were detected at soil boring locations SB-22, SB-26, SB-30, and SB-31 along the eastern portion of the unit. Soil samples from SB-31 and SB-30 exhibited the highest benzene derivative concentrations of 2.5 ppm and 2.49 ppm, respectively. Soil samples from isolated locations of the SWMU No. 17 including SB-25, SB-24, SB-21, and SB-22 also contained 2-butanone concentrations of 6.1 ppm, 4.2 ppm, 3.9 ppm, and 3.6 ppm, respectively. The soil sample from SB-35 along the southern portion of the unit exhibited a vinyl chloride concentration of 0.0096 ppm.

Only one of the twenty three soil samples collected from SWMU No. 17 contained a concentration which exceeded a VOC ITL. The 2-butanone level of 6.1 ppm at SB-25 exceeded the corresponding ITL of 5.2 ppm.

Various soil samples from SWMU No. 17 were also analyzed for non-RCRA TPH-related parameters. The highest TPH concentrations were generally detected along the eastern portion of the unit. Soil borings SB-30, SB-26, SB-21, and SB-22 exhibited extractable TPH concentrations of 1,400 ppm,

1,400 ppm, 1,100 ppm, and 740 ppm, respectively. Soil borings from SB-23 and SB-24 along the southern portion contained extractable TPH concentrations of 310 ppm and 270 ppm, respectively.

Seven of the twenty three soil samples collected from SWMU No. 17 contained a concentration which exceeded the ITL for extractable TPH.

Values for the SWMU No. 17 soil samples collected in 2001 were compared to the constituent-specific ITL values to evaluate the presence of significant constituent concentrations. As a result of this evaluation, the following additional soil-associated COCs at SWMU No. 17 will be retained for evaluation in the follow-up risk assessment: 2-butanone and TPH extractables.

## 6.3 Analytical Results for SWMU No. 17 Groundwater Samples

Analytical results for SWMU No. 17 groundwater samples collected in 2001 were utilized to further characterize the nature and extent of constituent releases to groundwater beneath this unit.

Groundwater samples from 6 monitoring wells (MW-6S, MW-7S, MW-8S, MW-9S, MW-10S, and MW-11S) and twenty five temporary piezometers (TP-1 thru TP-25) provided analytical data regarding shallow groundwater conditions. Groundwater samples acquired from MW-5I, MW-8I, MW-8D, MW-11I, and MW-11D were used to characterize groundwater conditions from deeper portions of the saturated unit. Analytical results for groundwater samples collected from the 31 monitoring wells/temporary piezometers are summarized in Tables 6-4 (Western), 6-5 (Southern), and 6-6 (Eastern). Results for various biodegradation parameters are summarized in Table 6-8. Groundwater sampling locations and associated analytical results for the quarterly monitoring events are provided in Figures 6-4 thru 6-7.

### 6.3.1 Chemical Parameters

Western Portion of Unit

*VOCs in Western Portion of Unit*

Ten (10) VOCs were detected in groundwater samples collected from the "western" portion of SWMU No. 17 (Source Area and interior portions of Building 51). Six of the sampling locations which exhibited the highest VOC concentrations were situated within and immediately downgradient to the unit (MW-7S, MW-5I, TP-5, TP-1, TP-2, and TP-11). Groundwater samples from MW-7S, TP-5, and MW-5I exhibited the highest total VOC concentrations of 598 ppm (October 2001), 555 ppm (October 2001), and 274 ppm (February 2001), respectively. An upgradient boundary was established to the west and north of SWMU

No. 17 where VOCs detected from TP-23, TP-19, TP-18, TP-14, and TP-24 were less than the corresponding ITLs.

PCE and several degradation products including TCE and cis-1,2-DCE were detected at the highest concentrations. Groundwater samples from MW-7S and TP-5 exhibited the highest PCE concentrations of 490 ppm (October 2001) and 400 ppm (October 2001), respectively. The sample from TP-5 also contained the highest cis-1,2-DCE level of 67 ppm (October 2001). Located approximately 70 feet downgradient (east) from MW-7S, the groundwater sample from MW-5I exhibited the highest TCE concentration of 270 ppm (February 2001).

Analytical results for the adjacent shallow and deeper monitoring wells (MW-6S and MW-5I, respectively) were also compared. While the detected VOC parameters for the two wells were similar, concentrations were significantly higher for samples from MW-5I. Maximum TCE and cis-1,2-DCE concentrations of 270 ppm and 4.6 ppm from MW-5I exceeded corresponding values of 0.12 ppm and 0.032 ppm from MW-6S. Vinyl chloride was detected in MW-6S (maximum of 0.053 ppm), but was not detected in MW-5I in 2001.

Of the four locations (MW-7S, TP-2, MW-6S, and MW-5I) from the western portion of the unit that were sampled during each of the 2001 quarterly events, several initial VOC trends were identified. VOC levels for vinyl chloride, TCE, and 1,2-DCE at MW-6S have generally decreased over the 1-year period. Similarly, TCE levels exhibited at MW-5I have continuously decreased over the 1-year period.

Other VOC constituents including ethylbenzene, toluene, and xylenes were generally detected at low concentrations, e.g. 50 ppb or less, and/or on an isolated basis.

*TPH in Western Portion of Unit*

TPH was detected in several groundwater samples collected from the western portion of SWMU No. 17. Two of the sampling locations which exhibited the highest TPH concentrations were situated within the northeast corner of Building 51 (260 ppm diesel at TP-24 and 110 ppm at TP-14). Groundwater samples from the southwest corner of Building 51 (TP-23) and an area downgradient (east) from the source (TP-11) also exhibited significantly elevated TPH levels. Extractable TPH levels from these 4 locations exceeded the ITL of 10 ppm.

Of the 4 locations (MW-7S, TP-2, MW-6S, MW-5I) from the western portion of the unit that were sampled during each of the 2001 quarterly events, no initial TPH trends were identified.

Southern Portion of Unit

*VOCs in Southern Portion of Unit*

Eight (8) VOCs were detected in groundwater samples collected from the "southern" portion of SWMU No. 17 (exterior locations to the south of the Building 51/Source Area). The sampling location which exhibited the highest VOC concentrations (TP-22) was situated near the collection point for a concrete stormwater drainage basin to the south of the caustic tanks. Groundwater samples from TP-22, TP-8, and TP-4 exhibited the highest total VOC concentrations of 2.4 ppm (October 2001), 0.33 ppm (September 2001), and 0.29 ppm (October 2001), respectively.

PCE and several degradation products including TCE, cis-1,2-DCE, and vinyl chloride were detected at the highest concentrations. Groundwater samples from TP-22 and TP-4 exhibited the highest PCE concentrations of 1.54 ppm (October 2001) and 0.15 ppm (October 2001), respectively. The sample from TP-22 also contained the highest cis-1,2-DCE level of 0.58 ppm (October 2001). Located approximately 50 feet downgradient (south) from TP-4, the groundwater sample from TP-8 exhibited the highest vinyl chloride concentration of 0.12 ppm (September 2001).

Low levels of PCE and MTBE were detected at MW-8S to the west of the caustic tanks. With the exception of the October 2001 level of 0.0058 ppm PCE, the detected concentrations were less than the corresponding VOC ITLs. Although no VOCs were detected at MW-8I during the initial three quarterly events, 0.013 ppm PCE was detected during the December 2001 quarterly event. This value exceeded the ITL of 0.005 ppm.

Of the three locations (MW-8S, MW-8I, and TP-4) from the southern portion of the unit that were sampled during each of the 2001 quarterly events, no initial VOC trends were identified.

*TPH in Southern Portion of Unit*

TPH was detected in several groundwater samples collected from the southern portion of SWMU No. 17. The two sampling locations which exhibited the highest TPH concentrations included TP-9 (1,100 ppm diesel) and TP-22 (24.5 ppm diesel). Extractable TPH levels from these 2 locations exceeded the ITL.

Of the three locations (MW-8S, MW-8I, and TP-4) from the southern portion of the unit that were sampled during each of the 2001 quarterly events, no initial TPH trends were identified.

Eastern Portion of Unit

*VOCs in Eastern Portion of Unit*

Ten (10) VOCs were detected in groundwater samples collected from the "eastern" portion of SWMU No. 17 (exterior locations to the east of Building 51/Source Area). Two of the sampling locations which exhibited the highest VOC concentrations were situated to the east (downgradient) of the unit (TP-3, TP-16). Groundwater samples from TP-3 and TP-16 exhibited the highest total VOC concentrations of 5.6 ppm (February 2001) and 1.3 ppm (September 2001), respectively. Further to the east, a similarly elevated total VOC concentration of 2.9 ppm was noted at TP-6. A downgradient boundary was established to the east of SWMU No. 17 where VOCs detected from TP-12, MW-11S, MW-11I, MW-11D, SB-17, and TP-13 have generally been less than the corresponding ITLs.

Solvent-related VOCs (PCE and TCE) were detected along the eastern portion of this area. Groundwater samples from TP-6 exhibited the highest TCE concentrations of 2.9 ppm (December 2001). No VOCs were detected at MW-11S during the February, October, or December 2001 quarterly events. However, groundwater samples from the July 2001 event exhibited detectable levels that exceeded ITLs (0.029 ppm PCE, 0.009 ppm TCE). Although MW-11D also exhibited primarily "non-detectable" results, isolated low levels of TCE (0.017 ppm and 0.0013 ppm) were detected at MW-11D during the October and December 2001 quarterly events, respectively. No VOCs were detected at MW-11I during the 2001 monitoring period.

Gasoline/fuel-related VOCs (BTEX, MTBE, benzene derivatives) were detected along the western portion of this area. Free product has been observed at MW-9S. Groundwater samples from TP-3, TP-16, and MW-9S exhibited the highest gasoline/fuel-related VOC concentrations. The February 2001 sample from TP-3 exhibited a benzene concentration of 0.68 ppm and a MTBE concentration of 1.4 ppm. Although benzene and MTBE were detected at TP-3 for the initial quarterly event, neither constituent was detected in any of the 3 subsequent quarterly monitoring events. Quarterly groundwater samples from MW-9S have exhibited detectable levels of BTEX and chlorinated VOC constituents (TCE, cis-1,2-DCE). With the exception of two benzene results (October 2001 and December 2001) and one TCE result (December 2001), the detected concentrations were less than the corresponding VOC ITLs.

Of the six locations (TP-3, MW-9S, MW-10S, MW-11S, MW-11I, and MW-11D) from the eastern portion of the unit that were sampled during each of the 2001 quarterly events, no initial VOC trends were identified.

*TPH in Eastern Portion of Unit*

TPH was detected in several groundwater samples collected from the eastern portion of SWMU No. 17. As previously indicated, free product has been observed at MW-9S. Groundwater samples from TP-15 (2,200 ppm), TP-16 (2,100 ppm), TP-7 (1,000 ppm diesel), MW-10S (330 ppm), TP-3 (45 ppm diesel), and TP-6 (20 ppm) also exhibited significant TPH levels. Extractable TPH levels from these 6 locations exceeded the ITL of 10 ppm.

Of the 6 locations (TP-3, MW-9S, MW-10S, MW-11S, MW-11I, MW-11D) from the eastern portion of the unit that were sampled during each of the 2001 quarterly events, TPH levels at MW-10S have increased over the 1-year period. No other initial trends were identified.

Comparison of SWMU No. 17 Groundwater Concentrations with ITLs

Maximum concentration values were determined for the monitoring well and temporary piezometer samples collected from SWMU No. 17 during 2001. These maximum values for the groundwater samples were compared to the constituent-specific ITL values to evaluate the presence of significant constituent concentrations in groundwater. Table 6-7 displays a comparison of the maximum and ITL values for groundwater samples from SWMU No. 17.

The vast majority of the COCs that exceeded ITL values were previously identified during the 1998 investigation efforts and retained for evaluation in the preliminary risk assessment. These COCs included benzene, 1,1-DCE, cis-1,2-DCE, trans-1,2-DCE, PCE, 1,1,2-trichloroethane, TCE, vinyl chloride. MTBE and TPH extractables represent the only new additions to the COC list for evaluation in the follow-up risk assessment. (The February 2001 groundwater sample from TP-3 exhibited the only MTBE concentration that exceeded the ITL.)

Although the detection of methylene chloride in 3 groundwater samples from the 1998 investigations was presumed to be associated with laboratory carryover, it was nonetheless retained/evaluated during the 2001 sampling events. Methylene chloride was not detected in any of the groundwater samples collected from SWMU No. 17 in 2000 or 2001. Hence, it will be removed from further evaluation in the follow-up risk assessment.

### 6.3.2 Biodegradation Parameters

Groundwater samples from selected monitoring wells and temporary piezometers provided data regarding biodegradation activity in the water-bearing units beneath SWMU No. 17. Analytical results and field measurements for biodegradation parameters are summarized in Table 6-8. Averaged quarterly results from 4 of the monitoring wells were then used in an EPA screening protocol to evaluate the extent of any anaerobic biodegradation by reductive dechlorination that is occurring at SWMU No. 17. Scoring results and associated interpretations are summarized in Table 6-9.

Monitoring wells in the western and eastern portions of the unit (MW-5I and MW-9S) exhibited biodegradation "scoring totals" of 17 and 16, respectively. These preliminary screening results indicate that adequate evidence exists that anaerobic biodegradation of chlorinated organics is at least occurring at these two locations. Monitoring well MW-7S exhibited a scoring result of 10 which indicates that evidence of anaerobic biodegradation is limited at this location. However, scoring totals are likely to be conservatively low due to masking of VOC concentrations (e.g. daughter product concentrations at MW-7S due to significant PCE/TCE levels) and absence of data for other screening parameters (e.g.carbon dioxide, methane, etc.). There is inadequate evidence of anaerobic degradation at the southwest portion of SWMU No. 17 where a low screening total of 5 was obtained for MW-8S. This result is expected since VOC levels at this location have been either very low and/or not detected.

## 6.4 Groundwater Field Measurements for SWMU No. 17

In addition to the collection of samples for laboratory analysis, groundwater samples were also evaluated for the following field parameters: pH, conductivity, and temperature. These results are summarized by parameter below.

pH values for SWMU No. 17 groundwater samples ranged from 6.3 to a high of 10.3. Most values generally ranged from pH 6.5 -7.5. The basic value of 10.3 was detected from TP-4 to the southwest of the unit. This reading represents the only pH value which indicates the presence of potentially abnormal groundwater conditions.

Conductivity values for SWMU No. 17 groundwater samples ranged from 600 - 6,300 $\mu$ohms/cm. Most values generally ranged from 800 - 3,500 $\mu$ohms/cm. The high end value of 6,300 $\mu$ohms/cm was detected from MW-11S to the east of the unit.

Temperature values for SWMU No. 17 groundwater samples ranged from 10 - 26°C. The lowest values were recorded during the February 2001 monitoring event while the highest values were recorded during the July 2001 monitoring event. None of the temperature results indicates the presence of any abnormal groundwater conditions.

## 6.5 Groundwater Elevation Data for SWMU No. 17

Groundwater level measurements were acquired to evaluate the direction and flowrate of groundwater in the shallow and intermediate units beneath SWMU No. 17. Static water level data were collected from selected temporary piezometers and monitoring wells during sampling events conducted in 1998; February 2001; May 2001; July 2001; and December 2001. Groundwater elevation maps for the 2001 quarterly monitoring events are displayed in Figures 6-8 thru 6-15. Groundwater level measurements for the monitoring events are provided in Table 6-10.

All eight groundwater surface maps for 2001 demonstrate a bi-directional flow of groundwater to the east (toward Coldwater Creek) and also to the south. Very low flow gradients are also indicated.

Horizontal flow gradients between selected shallow wells ranged from 0.0090 feet per foot (ft/ft) between MW-9S and MW-11S in February 2001 to 0.0403 ft/ft between MW-7S and MW-8S in December 2001. The average horizontal gradients for the shallow groundwater in 2001 were:

- 0.0252 ft/ft between MW-7S and MW-11S;
- 0.0146 ft/ft between MW-7S and MW-11S;
- 0.0152 ft/ft between MW-7S and MW-9S; and
- 0.0136 ft/ft between MW-9S to MW-11S.

Horizontal flow gradients in the intermediate wells ranged from a minimum of 0.002 ft/ft between MW-5I and MW-11I in Oct/Dec 2001 to a maximum of 0.014 ft/ft between MW-5I and MW-8I in February 2001. The average horizontal gradients for intermediate groundwater in 2001 were:

- 0.008 ft/ft between MW-5I and MW-8I; and
- 0.003 ft/ft between MW-5I and MW-11I.

The groundwater surface maps also indicate the apparent presence of a groundwater elevation high in the vicinity of MW-7S at the southeast corner of Building 51. This effect may be due to the presence of a subsurface structure in the southeastern corner of Building 51 that extends to a depth of approximately 15 ft bls. This concrete structure is approximately 8 feet wide by 20 feet long and contained a tank that was part of the former mask line. Granular fill may be surrounding the structure and could be contributing to the apparent mounding of groundwater in this area. This assertion is further supported by the fact that the shallow monitoring wells cannot be sampled by low flow methods without going dry at pumping rates of less than 100 ml/min, while MW-7S produced a constant flow of 1,000 ml/min with nearly stabilized drawdown of less than two feet.

TABLE 6-1

Detected Constituent Concentrations for SWMU 17 Soil Samples
(Western Portion of Unit)
McDonnell Douglas RFI

| CONSTITUENT | UNITS | SAMPLE ID NUMBERS AND RESULTS | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | SB-38 | SB-34 | SB-25 | SB-40 | SB-33 | SB-18 | | SB-11 (TP-5) | | SB-39 | SB-29 | SB-32 | SB-14 (MW-7S) | S17B1 | | | | *INVESTIGATION THRESHOLD* |
| | | (6' - 7') | (8' - 9') | (6' - 7') | (6' - 7') | (7' - 8') | (11' - 12') | (15' - 16') | (7' - 8') | (15' - 16') | (6' - 7') | (8' - 9') | (8' - 9') | (14' - 15') | (2.5' - 4') | (2.5' - 4' Dupe) | (12' - 13') | (16' - 17') | *LEVEL (ITL)* |
| | | 10/15/01 | 9/6/01 | 9/5/01 | 10/15/01 | 9/6/01 | 12/7/00 | 12/7/00 | 12/7/00 | 12/7/00 | 10/15/01 | 9/6/01 | 9/6/01 | 12/5/00 | 2/4/98 | 2/4/98 | 2/4/98 | 2/4/98 | |
| ***Volatile Organics*** | | | | | | | | | | | | | | | | | | | |
| Acetone | ug/kg | <5 | <250 | <2,500 | <5 | <250 | <10 | 130 | <100 | 130 | <5 | <250 | <250 | NA | 240 | <1,600 | 21 | 20 | *16,000* |
| 2-Butanone | ug/kg | <5 | <250 | 6,100 | <5 | <250 | <10 | <100 | <100 | <10 | <5 | <250 | <250 | NA | NA | NA | NA | NA | *5,200* |
| cis-1,2-Dichloroethene | ug/kg | <5 | <5 | <50 | <5 | <5 | 140 | 68,000 | 500 | 57,000 | <5 | <5 | <5 | NA | <3,200 | <810 | 22 | 88 | *400* |
| trans-1,2-Dichloroethene | ug/kg | <5 | <5 | <50 | <5 | <5 | <5 | <5,000 | <50 | 7,200 | <5 | <5 | <5 | NA | 9.6 | 36 | <6.4 | <6.8 | *700* |
| Ethylbenzene | ug/kg | <5 | <5 | <50 | <5 | <5 | <5 | 400 | <50 | 49 | <5 | <5 | <5 | NA | NA | NA | NA | NA | *13,000* |
| Methylene chloride | ug/kg | <5 | <25 | <250 | <5 | <25 | 8 B | 43 J,B | 28 J,B | 5 B | <5 | <25 | <25 | NA | NA | NA | NA | NA | *20* |
| Perchloroethene | ug/kg | <5 | <5 | <50 | <5 | <5 | 800 | 9,300,000 | 1,700,000 | 440 J | <5 | <5 | <5 | NA | 24,000 | 32,000 | 9,100 | 58,000 | *60* |
| Toluene | ug/kg | <5 | <25 | <250 | <5 | <25 | <5 | 1,600 | <50 | 650 | <5 | <25 | <25 | NA | NA | NA | NA | NA | *12,000* |
| 1,1,2-Trichloroethane | ug/kg | <5 | <5 | <50 | <5 | <5 | <5 | <50 | <50 | <5 | <5 | <5 | <5 | NA | NA | NA | NA | NA | *20* |
| Trichloroethene | ug/kg | <5 | <5 | <50 | <5 | <5 | 90 | 14,000 | 2,200 | 1,900 | <5 | <5 | <5 | NA | NA | NA | NA | NA | *60* |
| Xylenes, Total | ug/kg | <5 | <15 | <150 | <5 | <15 | <5 | 1,600 | <50 | 180 | <5 | <15 | <15 | NA | 41 | 230 | <6.4 | 7.7 | *200,000* |
| Benzene Derivatives | ug/kg | <5 | <5 | <50 | <5 | <5 | <5 | 35 J | <50 | <5 | <5 | 27 | <5 | NA | NA | NA | NA | NA | *NA* |
| Total Purgeable Hydrocarbons | mg/kg | <5 | NA | NA | <5 | NA | NA | NA | NA | NA | <5 | NA | NA | 9.1 (TEX) | NA | NA | NA | NA | *200* |
| Total Extractable Hydrocarbons | mg/kg | <5 | 4.5 | 9.3 | <5 | 5.5 (misc.) | NA | NA | NA | NA | <5 | 970 | 88 (misc.) | <3 | NA | NA | NA | NA | *200* |
| ***Metals/Inorganics*** | | | | | | | | | | | | | | | | | | | |
| Arsenic | mg/kg | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 10 | <6.4 | 20 | 15 | *77* |
| Barium | mg/kg | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 210 | 160 | 100 | 110 | *1,750* |
| Cadmium | mg/kg | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | <0.63 | <0.64 | 0.65 | <0.68 | *8* |
| Chromium | mg/kg | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 19 | 18 | 21 | 21 | *85* |
| Lead | mg/kg | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 15 | 8.5 | 13 | 11 | *400* |
| Mercury | mg/kg | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | <0.03 | 0.48 | 0.05 | 0.56 | *2* |
| Selenium | mg/kg | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 1.2 | 1.4 | 1 | <0.68 | *5* |

| CONSTITUENT | UNITS | SAMPLE ID NUMBERS AND RESULTS | | | | | | | | | | | | | | | | | | *INVESTIGATION THRESHOLD* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | S17B4 | | | S17B2 | | S17B3 | S17B5 | | S17B10 | | | S17B9 | | | | | SB-26 | |
| | | (6' - 7') | (11.5' - 13.5') | (14' - 16') | (3' - 4.5') | (11' - 12.5') | (10.5' - 11.5') | (5.5' - 7') | (14' - 16') | (4' - 5') | (10.5' - 11.5') | (14' - 15') | (26' - 27') | (26' - 27' Dupe) | (34' - 35') | (41' - 42') | (44' - 45') | (6' - 7') | *LEVEL (ITL)* |
| | | 2/4/98 | 2/4/98 | 2/4/98 | 2/4/98 | 2/4/98 | 2/4/98 | 2/4/98 | 2/4/98 | 4/20/98 | 4/20/98 | 4/20/98 | 4/21/98 | 4/21/98 | 4/21/98 | 4/21/98 | 4/21/98 | 9/5/01 | |
| ***Volatile Organics*** | | | | | | | | | | | | | | | | | | | |
| Acetone | ug/kg | 27 | <14 | 400 | 25 | <13 | 16 | 42 | <77 | 26 | <13 | 180 | 39 | 48 | 40 | 16 | 34 | <12,000 | *16,000* |
| 2-Butanone | ug/kg | NA | NA | NA | NA | NA | NA | <13 | NA | <13 | <6.3 | 50 | <12 | <12 | <6.2 | <6.5 | <6.5 | <12,000 | *5,200* |
| cis-1,2-Dichloroethene | ug/kg | 13 | 760 | 11,900 | <6.5 | 46 | 24 | <6.5 | 280 | <6.3 | <6.3 | <7.4 | 160 | 110 | <6.2 | 13 | 17 | <250 | *400* |
| trans-1,2-Dichloroethene | ug/kg | <6.7 | <7.2 | <19,000 | <6.5 | <6.4 | <6.7 | <6.5 | <38 | <6.3 | <6.3 | 24 | <6.2 | <6.2 | <6.2 | <6.5 | <6.5 | <250 | *700* |
| Ethylbenzene | ug/kg | NA | NA | NA | NA | NA | NA | <6.5 | NA | <6.3 | <6.3 | <7.4 | <6.2 | <6.2 | <6.2 | <6.5 | <6.5 | <250 | *13,000* |
| Methylene chloride | ug/kg | NA | NA | NA | NA | NA | NA | <6.5 | NA | 24 | <6.3 | 69 | 19 B | 26 B | 22 B | 18 B | 16 B | <1,200 | *20* |
| Perchloroethene | ug/kg | 12,000 | 200,000 | 240,000 | 18,000 | 1,100 | 3,000 | 35 | 3,600 | <6.3 | <6.3 | <7.4 | <6.2 | <6.2 | <6.2 | 8.0 | 8.1 | <250 | *60* |
| Toluene | ug/kg | NA | NA | NA | NA | NA | NA | <6.5 | NA | <6.3 | <6.3 | <7.4 | <6.2 | <6.2 | <6.2 | <6.5 | <6.5 | <1,200 | *12,000* |
| 1,1,2-Trichloroethane | ug/kg | NA | NA | NA | NA | NA | NA | <6.5 | NA | <6.3 | <6.3 | <7.4 | 180 | 380 | 18 | <6.5 | <6.5 | <250 | *20* |
| Trichloroethene | ug/kg | NA | NA | NA | NA | NA | NA | <6.5 | NA | 9.3 | 64 | 28 | 12,000 | 8,200 | 39 | 1,800 | 7,900 | <250 | *60* |
| Xylenes, Total | ug/kg | <6.7 | 180 | <19,000 | <6.5 | <6.4 | <6.7 | <6.5 | <38 | <6.3 | <6.3 | <7.4 | <6.2 | <6.2 | <6.2 | <6.5 | <6.5 | <750 | *200,000* |
| Benzene Derivatives | ug/kg | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | <250 | *NA* |
| Total Purgeable Hydrocarbons | mg/kg | NA | NA | NA | NA | NA | NA | 180 | NA | NA | NA | NA | NA | NA | NA | NA | NA | <400,000 | *200* |
| Total Extractable Hydrocarbons | mg/kg | NA | NA | NA | NA | NA | NA | 1,900 | NA | NA | NA | NA | NA | NA | NA | NA | NA | 1,400 | *200* |
| ***Metals/Inorganics*** | | | | | | | | | | | | | | | | | | | |
| Arsenic | mg/kg | 20 | <7.2 | 9.7 | 10 | 11 | <6.6 | NA | <7.6 | NA | NA | NA | NA | NA | NA | NA | NA | NA | *77* |
| Barium | mg/kg | 130 | 79 | 86 | 310 | 80 | 170 | NA | 82 | NA | NA | NA | NA | NA | NA | NA | NA | NA | *1,750* |
| Cadmium | mg/kg | <0.67 | <0.72 | <0.75 | 0.88 | <0.63 | <0.66 | NA | <0.76 | NA | NA | NA | NA | NA | NA | NA | NA | NA | *8* |
| Chromium | mg/kg | 21 | 13 | 13 | 22 | 12 | 14 | NA | 12 | NA | NA | NA | NA | NA | NA | NA | NA | NA | *85* |
| Lead | mg/kg | 16 | 9.8 | 7.5 | 11 | 11 | 8.9 | NA | 9 | NA | NA | NA | NA | NA | NA | NA | NA | NA | *400* |
| Mercury | mg/kg | 0.55 | 0.55 | 0.55 | 0.54 | 0.52 | 0.53 | NA | 0.05 | NA | NA | NA | NA | NA | NA | NA | NA | NA | *2* |
| Selenium | mg/kg | <0.67 | 0.72 | <0.74 | 0.86 | <0.63 | <0.66 | NA | 1.6 | NA | NA | NA | NA | NA | NA | NA | NA | NA | *5* |

*Notes:*

< This compound was not detected at or above the associated numerical value. (Quantitation limit shown.)
J This concentration for this constituent was an estimated value.
B This compound was detected in the lab method blank.
NA Not analyzed.
TEX Toluene, Ethylbenzene, and Xylene

(1) Metals were not analyzed for samples from soil borings from supplemental investigations including SB-9, SB-10, SB-11, SB-14, or SB-18.
Shaded values indicate constituent concentrations which exceed the investigation threshold levels.

TABLE 6-2

Detected Constituent Concentrations for SWMU 17 Soil Samples
(Southern Portion of Unit)
McDonnell Douglas RFI

| CONSTITUENT | UNITS | SAMPLE ID NUMBERS AND RESULTS | | | | | | | | | | | INVESTIGATION THRESHOLD LEVEL (ITL) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | S17B8 | | SB-13 | S17B7 | | | SB-24 | SB-23 | SB-37 | SB-36 | SB-35 | |
| | | (6' - 7') | (11.5' - 12.5') | (9' - 10') | (3.5' - 4.5') | (7.5' - 8.5') | (31.5' - 32.5') | (8'- 9') | (8'- 9') | (6'- 7') | (3'- 4') | (6'- 7') | |
| | | 2/6/98 | 2/6/98 | 12/4/00 | 2/6/98 | 2/6/98 | 2/6/98 | 9/5/01 | 9/5/01 | 10/15/01 | 10/15/01 | 10/15/01 | |
| *Volatile Organics* | | | | | | | | | | | | | |
| Acetone | ug/kg | **30** | **25** | <26 | **68** | **35** | **50** | <2,500 | <2,500 | <5 | <5 | <5 | *16,000* |
| 2-Butanone | ug/kg | **52** | **58** | <26 | **82** | **52** | **49** | **4,200** | **3,600** | <5 | <5 | <5 | *5,200* |
| cis-1,2-Dichloroethene | ug/kg | <6.3 | **10** | **19** | <6.6 | <6.4 | <6.5 | <50 | <50 | <5 | <5 | <5 | *400* |
| trans-1,2-Dichloroethene | ug/kg | <6.3 | <6.3 | <3.2 | <6.6 | <6.4 | <6.5 | <50 | <50 | <5 | <5 | <5 | *700* |
| Ethylbenzene | ug/kg | <6.3 | <6.3 | <6.4 | **13** | <6.4 | <6.5 | <50 | <50 | <5 | <5 | <5 | *13,000* |
| Methylene chloride | ug/kg | **6.7** | <6.3 | **20** | **6.7** | **6.5** | **6.9** | <2,500 | <2,500 | <5 | <5 | <5 | *20* |
| Perchloroethene | ug/kg | **12** | **58** | <6.4 | **4,200** | **9.7** | **7.7** | <50 | <50 | <5 | <5 | <5 | *60* |
| Toluene | ug/kg | <6.3 | <6.3 | <6.4 | **20** | <6.4 | <6.5 | <250 | <250 | <5 | <5 | <5 | *12,000* |
| 1,1,2-Trichloroethane | ug/kg | <6.3 | <6.3 | <6.4 | <6.6 | <6.4 | <6.5 | <50 | <50 | <5 | <5 | <5 | *20* |
| Trichloroethene | ug/kg | <6.3 | <6.3 | <6.4 | **44** | <6.4 | <6.5 | <50 | <50 | <5 | <5 | <5 | *60* |
| Xylenes, Total | ug/kg | <6.3 | <6.3 | <6.4 | <6.6 | <6.4 | <6.5 | <150 | <150 | <5 | <5 | <5 | *200,000* |
| Vinyl chloride | ug/kg | <13 | <13 | <13 | <13 | <13 | <13 | <50 | <50 | <5 | <5 | **9.6** | *10* |
| Benzene Derivatives | ug/kg | NA | NA | NA | NA | NA | NA | **97** | <50 | <5 | <5 | <5 | *NA* |
| Total Purgeable Hydrocarbons | mg/kg | NA | NA | **0.157** | NA | NA | NA | NA | NA | NA | NA | NA | *200* |
| Total Extractable Hydrocarbons | mg/kg | NA | NA | <5 | NA | NA | NA | **270** (misc.) | **310** (misc.) | <5 | <5 | <5 | *200* |

*Notes:*

< This compound was not detected at or above the associated numerical value. (Quantitation limit shown.)
NA Not analyzed.

Shaded values indicate constituent concentrations which exceed the investigation threshold levels.

TABLE 6-3

Detected Constituent Concentrations for SWMU 17 Soil Samples
(Eastern Portion of Unit)
McDonnell Douglas RFI

| CONSTITUENT | UNITS | SAMPLE ID NUMBERS AND RESULTS | | | | | | | | | | | | | | INVESTIGATION THRESHOLD LEVEL (ITL) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | S17B6 (9.5' - 11') 2/5/98 | SB-31 (6' - 7') 9/6/01 | SB-20 (7' - 8') 12/7/00 | SB-20 (15' - 16') 12/7/00 | SB-30 (6' - 7') 9/6/01 | SB-12 (MW-10S) (10' - 11') 12/4/00 | SB-12 (MW-10S) (10' - 11' Dupe) 12/4/00 | SB-21 (8' - 9') 9/5/01 | SB-15 (9' - 10') 12/4/00 | SB-22 (8' - 9') 9/5/01 | SB-27 (8' - 9') 9/5/01 | SB-16 (9' - 10') 12/4/00 | SB-28 (8' - 9') 9/5/01 | SB-17 (10' - 11') 12/7/00 | |
| *Volatile Organics* | | | | | | | | | | | | | | | | |
| Acetone | ug/kg | **15** | <250 | <100 | **90** | <12,000 | <1,300 | NA | <2,500 | **34** | <2,500 | <250 | **39** | <5,000 | <10 | *16,000* |
| 2-Butanone | ug/kg | <13 | <250 | <100 | **36** | <12,000 | <1,300 | NA | **3,900** | <26 | <2,500 | <250 | <26 | <5,000 | <10 | *5,200* |
| cis-1,2-Dichloroethene | ug/kg | <6.6 | <5 | <50 | <5 | <250 | <310 | NA | <50 | <3.2 | <50 | <5 | <3.2 | <100 | <5 | *400* |
| trans-1,2-Dichloroethene | ug/kg | <6.6 | <5 | <50 | <5 | <250 | <310 | NA | <50 | <3.2 | <50 | <5 | <3.2 | <100 | <5 | *700* |
| Ethylbenzene | ug/kg | <6.6 | <5 | <50 | <5 | <250 | <310 | NA | <50 | <6.5 | <50 | <5 | <6.3 | <100 | <5 | *13,000* |
| Methylene chloride | ug/kg | <6.6 | <25 | **40** J,B | **8** B | <1,200 | <310 | NA | <250 | **26** | <250 | <25 | **27** | <500 | **8** B | *20* |
| Perchloroethene | ug/kg | <6.6 | <5 | <50 | <5 | <250 | <310 | NA | <50 | <6.5 | <50 | <5 | <6.3 | <100 | **6** B | *60* |
| Toluene | ug/kg | <6.6 | <25 | **26** J | <5 | <1,200 | <310 | NA | <250 | <6.5 | <250 | <25 | <6.3 | <500 | <5 | *12,000* |
| 1,1,2-Trichloroethane | ug/kg | <6.6 | <5 | <50 | <5 | <250 | <310 | NA | <50 | <6.5 | <50 | <5 | <6.3 | <100 | <5 | *20* |
| Trichloroethene | ug/kg | <6.6 | <5 | <50 | <5 | <250 | <310 | NA | <50 | <6.5 | <50 | <5 | <6.3 | <100 | <5 | *60* |
| Xylenes, Total | ug/kg | <6.6 | <15 | <50 | <5 | <750 | <310 | NA | <150 | <6.5 | <150 | <15 | <6.3 | <300 | <5 | *200,000* |
| Benzene Derivatives | ug/kg | NA | **2,500** | **870** | **34** | **2,490** | <310 | NA | **97** | NA | **1,430** | <5 | NA | <100 | <5 | *NA* |
| Total Purgeable Hydrocarbons | mg/kg | **25** | NA | NA | NA | NA | **260** (gasoline) | **302** (gasoline) | NA | **0.002** | NA | NA | <0.001 | NA | <0.001 | *200* |
| Total Extractable Hydrocarbons | mg/kg | **450** | **126** (misc/motor oil) | NA | NA | **1,400** (misc.) | **6,360** (diesel #2) | **6,100** (diesel #2) | **1,100** (misc.) | **470** (diesel) | **740** (misc.) | **16** (misc.) | **10.4** (diesel) | **180** (misc.) | <3 | *200* |

*Notes:*

< This compound was not detected at or above the associated numerical value. (Quantitation limit shown.)
J This concentration for this constituent was an estimated value.
B This compound was detected in the lab method blank.
NA Not analyzed.

Shaded values indicate constituent concentrations which exceed the investigation threshold levels.

**Table 6-4**
**Detected Constituent Concentrations for SWMU-17 Groundwater Samples**
**(Western Portion of Unit)**
**McDonnell Douglas RFI**

| CONSTITUENT | UNITS | MW-5I | | | | | MW-6S | | | | MW-7S | | | | TP-1 | TP-2 | | | | INVESTIGATION THRESHOLD LEVEL (ITL)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Feb '01 | Feb '01 Dup | July '01 | Oct '01 | Dec '01 | Feb '01 | July '01 | Oct '01 | Dec '01 | Feb '01 | July '01 | Oct '01 | Dec '01 | Feb '01 | Feb '01 | July '01 | Oct '01 | Dec '01 | |
| ***Volatile Organics*** | | | | | | | | | | | | | | | | | | | | |
| 1,1,2-Trichloroethane | ug/l | <500 | <1,000 | <2,000 | <5,000 | **180** | <10 | <1 | <1 | <1 | <500 | <10,000 | <2,000 | <1000 | <1,000 | <1 | <250 | <1,000 | <50 | ***5*** |
| Cis-1,2-Dichloroethene | ug/l | **3,500** | **4,600** | **2,600** | <5,000 | **2,100** | **32** | **7.6** | **14** | **6** | **5,800** | <10,000 | **36,000** | **9,400** | **58,000** | <1 | **4,100** | **5,800** | **6,400E** | ***70*** |
| Ethylbenzene | ug/l | <500 | <1,000 | <2,000 | <5,000 | <50 | <10 | <1 | <1 | <1 | <500 | <10,000 | <2,000 | <1,000 | <1,000 | <1 | <500 | <1,000 | <50 | ***700*** |
| N-Butylbenzene | ug/l | <500 | <1,000 | <2,000 | <5,000 | <50 | <10 | <1 | <1 | <1 | <500 | <10,000 | <2,000 | <1,000 | <1,000 | 1.4 | <250 | <1,000 | <50 | -- |
| Sec-Butylbenzene | ug/l | <500 | <1000 | <2,000 | <5,000 | <50 | <10 | <1 | <1 | <1 | <500 | <10,000 | <2,000 | <1,000 | <1,000 | <1 | <250 | <1,000 | <50 | -- |
| Tetrachloroethene | ug/l | <500 | <1,000 | <2,000 | <5,000 | **72** | <10 | <1 | <1 | <1 | **130,000E** | **66,000** | **490,000E** | **64,000E** | **110,000E** | <1 | **12,000J** | **12,000** | **17,000E** | ***5*** |
| Toluene | ug/l | <500 | <1,000 | <10,000 | <25,000 | <250 | <10 | <5 | <5 | <5 | <500 | <50,000 | <10,000 | <5,000 | <1,000 | <1 | <1200 | <5,000 | <250 | ***1,000*** |
| Trans-1,2-Dichloroethene | ug/l | <500 | <1,000 | <2,000 | <5,000 | <50 | <10 | <1 | **2** | <1 | <500 | <10,000 | <2,000 | <1,000 | <1,000 | <1 | <250 | <1,000 | <50 | ***100*** |
| Trichloroethene | ug/l | **270,000E** | **230,000E** | **160,000E** | **150,000** | **60,000E** | **120** | <1 | <1 | <1 | **10,000** | <10,000 | **72,000** | **5,800** | **4,200** | <1 | **3,200** | **4,200** | **3,800E** | ***5*** |
| Vinyl Chloride | ug/l | <500 | <1,000 | <2,000 | <5,000 | **170** | **53** | **16J** | **30** | **7.5** | <500 | <10,000 | <2,000 | <1,000 | <1,000 | <1 | <250 | <1,000 | **70** | ***2*** |
| Xylenes, Total | ug/l | <1500 | <3,000 | <6,000 | <15,000 | <150 | <30 | <3 | <3 | <3 | <1500 | <30,000 | <6,000 | <3,000 | <3,000 | <3 | <750 | <3,000 | <150 | ***10,000*** |
| ***TPH*** | | | | | | | | | | | | | | | | | | | | |
| #6 Fuel Oil (C10-C32) | ug/l | <100 | NA | NA | NA | NA | <100 | NA | NA | NA | <100 | NA | NA | NA | <100 | <100 | NA | NA | NA | -- |
| Diesel (C7-C26) | ug/l | <100 | NA | NA | NA | NA | <100 | NA | NA | NA | <100 | NA | NA | NA | <100 | <100 | NA | NA | NA | -- |
| Miscellaneous TPH | ug/l | <100 | NA | NA | NA | NA | <100 | NA | NA | NA | <100 | NA | NA | NA | <100 | <100 | NA | NA | NA | -- |
| Motor Oil (C16-C33) | ug/l | <100 | NA | NA | NA | NA | **380J** | NA | NA | NA | <100 | NA | NA | NA | **570** | **160** | NA | NA | NA | -- |
| TPH (GC/FID) Low Fraction | ug/l | **100,000** | NA | NA | NA | NA | **650** | NA | NA | NA | **45,000E** | NA* | NA | NA | **110,000E** | **10,000** | NA | NA | NA | ***10,000*** |
| TPH (GC/FID) High Fraction | ug/l | NA | NA | <100 | **90** | <100 | NA | <100 | **310** | **300J** | NA | <100 | <100 | **230** | NA | NA | <100 | **190** | **180J** | ***10,000*** |

| CONSTITUENT | UNITS | TP-5 | | | TP-10 | TP-11 | TP14 | TP-17 | | TP-18 | TP-19 | | TP 23 | TP-24 | | TP-25 | INVESTIGATION THRESHOLD LEVEL (ITL)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Feb '01 | July '01 | Oct '01 | Sept '01 | Sept '01 | Sept '01 | Sept '01 | Sept '01 Dup | Sept '01 | Sept '01 | Sept '01 Dup | Oct '01 | Oct '01 | Oct '01 Dup | Oct '01 | |
| ***Volatile Organics*** | | | | | | | | | | | | | | | | | |
| 1,1,2-Trichloroethane | ug/l | <2,500 | <1,000 | <2,000 | <250 | <250 | <500 | <10 | <10 | <1 | <1 | <1 | NA | <1 | <1 | <1 | ***5*** |
| Cis-1,2-Dichloroethene | ug/l | **5,700** | **4,600** | **67,000** | **2,700** | **9,300** | <500 | **73** | **66** | **12** | **3.6** | **4** | <5 | <1 | <1 | **3.1** | ***70*** |
| Ethylbenzene | ug/l | <2,500 | <1,000 | <2,000 | <250 | <250 | <500 | <10 | <10 | <1 | <1 | <1 | **6.8** | <1 | <1 | <1 | ***700*** |
| N-Butylbenzene | ug/l | <2,500 | <1,000 | <2,000 | <250 | <250 | <500 | <10 | <10 | <1 | <1 | <1 | NA | <1 | <1 | <1 | -- |
| Sec-Butylbenzene | ug/l | <2,500 | <1,000 | <2,000 | <250 | <250 | <500 | <10 | <10 | <1 | <1 | <1 | NA | **34** | **23** | <1 | -- |
| Tetrachloroethene | ug/l | **44,000** | **31,000** | **400,000E** | **10,000** | **4,300** | <500 | **270** | **190** | <1 | **3.6** | **4** | <5 | <1 | <1 | <1 | ***5*** |
| Toluene | ug/l | <2,500 | <5,000 | <10,000 | <1,200 | <1,200 | <2,500 | <50 | <50 | <5 | <5 | <5 | **9.6** | <5 | <5 | <5 | ***1,000*** |
| Trans-1,2-Dichloroethene | ug/l | <2,500 | <1,000 | <2,000 | <250 | <250 | <500 | <10 | <10 | **1.6** | <1 | <1 | <5 | <1 | <1 | <1 | ***100*** |
| Trichloroethene | ug/l | **4,400** | **5,900** | **84,000** | **1,100** | **860J** | <500 | **15** | <10 | <1 | **1.3** | **1** | <5 | <1 | <1 | <1 | ***5*** |
| Vinyl Chloride | ug/l | <2,500 | <1,000 | **4,400** | <250 | **1,600** | <500 | <10 | <10 | **1** | <1 | <1 | <5 | <1 | <1 | <1 | ***2*** |
| Xylenes, Total | ug/l | <7,500 | <3,000 | <6,000 | <750 | <750 | <1,500 | <30 | <30 | <3 | <3 | <3 | **195.8** | <3 | <3 | <3 | ***10,000*** |
| ***TPH*** | | | | | | | | | | | | | | | | | |
| #6 Fuel Oil (C10-C32) | ug/l | <100 | NA | NA | <100 | <4,000 | <10,000 | <1,000 | <100 | <100 | <100 | <100 | **212,199** | <10,000 | <10,000 | <100 | -- |
| Diesel (C7-C26) | ug/l | <100 | NA | NA | <100 | **14,000** | **110,000** | **10,000** | <100 | <100 | <100 | <100 | NA | **260,000J** | **65,000** | <100 | -- |
| Miscellaneous TPH | ug/l | <100 | NA | NA | **2,000** | <4,000 | <10,000 | <1,000 | **2,400** | **140** | **160** | **110** | NA | <10,000 | <10,000 | **350** | -- |
| Motor Oil (C16-C33) | ug/l | <100 | NA | NA | <100 | <4,000 | <10,000 | <1,000 | <100 | <100 | <100 | <100 | <1,000 | <10,000 | <10,000 | <100 | -- |
| TPH (GC/FID) Low Fraction | ug/l | **27,000J** | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | ***10,000*** |
| TPH (GC/FID) High Fraction | ug/l | NA | <100 | <100 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | ***10,000*** |

*Notes:*

< The compound was not detected above this quantitation limit.
* Draft Annual Monitoring Report for SWMU 17 McDonnell Douglas, Hazelwood, Missouri Facility, January 25, 2002, Harding ESE, Inc.
-- ITL has not been established.
J Value qualified as an estimate.
E Actual value is known to be greater than the upper calibration range.

Shaded values indicate constituent concentrations which exceed the ITLs.

Table 6-5
Detected Constituent Concentrations for SWMU-17 Groundwater Samples
(Southern Portion of Unit)
McDonnell Douglas RFI

| CONSTITUENT | UNITS | MW8S | | | | | | MW8I | | | | TP 4 | | | | TP-8 | TP-9 | TP20 | | TP-21 | | TP-22 | INVESTIGATION THRESHOLD LEVEL (ITL)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | July '01 | July '01 Dup | Oct '01 | Oct '01 Dup | Dec '01 | Dec '01 Dup | Feb '01 | July '01 | Oct '01 | Dec '01 | Feb '01 | July '01 | Oct '01 | Dec '01 | Sept '01 | Sept '01 | Oct '01 | Oct '01 Dup | Oct '01 | Oct '01 Dup | Oct '01 | |
| ***Volatile Organics*** | | | | | | | | | | | | | | | | | | | | | | | |
| 1,1-Dichloroethane | ug/l | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <2 | <1 | <1 | <500 | **6.1** | <1 | <5 | <5 | <5 | ***4,000*** |
| Cis-1,2-Dichloroethene | ug/l | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | **5.6** | **8.6** | **100E** | **14** | **200E** | <500 | <5 | <1 | **155.6** | **140.3** | **581.2** | ***70*** |
| Methyl Tert-Butyl Ether | ug/l | <1 | **3.1J** | <1 | **1.2** | <1 | **1** | <5 | <1 | **1.3** | <1 | <5 | <1 | <2 | <1 | <1 | <500 | <5 | <1 | <5 | <5 | <5 | ***400*** |
| Naphthalene | ug/l | <1 | <1 | <1 | <3 | <1 | <1 | <1 | <1 | <3 | <1 | **2.2** | **5.4** | <6 | <15 | <5 | <2,500 | NA | <1 | NA | NA | NA | -- |
| Tetrachloroethene | ug/l | **3.4** | **2** | <1 | **5** | **2.8** | **3.4** | <1 | <1 | **5.8** | **13** | **79** | **79E** | **150E** | **35** | **4.4** | <500 | <5 | <1 | <5 | <5 | **1,540.87** | ***5*** |
| Trans-1,2-Dichloroethene | ug/l | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | **1.4** | <1 | <2 | <1 | **4.2** | <500 | <5 | **11** | <5 | <5 | **5.3** | ***100*** |
| Trichloroethene | ug/l | <1 | <1 | <2 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | **8.7** | **6.7** | **33** | **10** | <1 | <500 | <5 | <1 | <5 | <5 | **139.9** | ***5*** |
| Vinyl Chloride | ug/l | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | **2** | **1.3** | **5** | **5.2** | **120E** | <500 | **30.1** | **55E** | **26.3** | **31.5** | **108.1** | ***2*** |
| ***TPH*** | | | | | | | | | | | | | | | | | | | | | | | |
| #6 Fuel Oil (C10-C32) | mg/l | NA | NA | NA | NA | NA | NA | <100 | NA | NA | NA | <100 | NA | NA | NA | <100 | <100,000 | <1,000 | <100 | <1,000 | <1,000 | **24,472** | -- |
| Diesel (C7-C26) | mg/l | NA | NA | NA | NA | NA | NA | <100 | NA | NA | NA | **290** | NA | NA | NA | <100 | **1,100,000** | NA | <100 | NA | NA | NA | -- |
| Miscellaneous TPH | mg/l | NA | NA | NA | NA | NA | NA | <100 | NA | NA | NA | <100 | NA | NA | NA | **1,400** | <100,000 | NA | **570J** | NA | NA | NA | -- |
| Motor Oil (C16-C33) | mg/l | NA | NA | NA | NA | NA | NA | **160** | NA | NA | NA | <100 | NA | NA | NA | <100 | <100000 | <1000 | <100 | <1000 | <1000 | <1000 | -- |
| TPH (GC/FID) High Fraction | mg/l | <100 | <100 | **180** | **150** | <100 | <100 | NA | <100 | **150** | <100 | NA | **150** | **210** | **230J** | NA | NA | NA | NA | NA | NA | NA | ***10,000*** |
| ***Metals*** | | | | | | | | | | | | | | | | | | | | | | | |
| Aluminum, Dissolved | ug/l | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | **1,600** | NA | NA | NA | NA | NA | NA | NA | NA | -- |
| Arsenic, Dissolved | ug/l | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | **5.6** | NA | NA | **130** | NA | NA | NA | NA | NA | -- |
| Barium, Dissolved | ug/l | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | **24J** | NA | NA | **1,600** | NA | NA | NA | NA | NA | -- |
| Cadmium, Dissolved | ug/l | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | <2 | NA | NA | **5.4** | NA | NA | NA | NA | NA | -- |
| Chromium, Dissolved | ug/l | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | <2 | NA | NA | **19** | NA | NA | NA | NA | NA | -- |
| Lead, Dissolved | ug/l | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | <5 | NA | NA | **6.7** | NA | NA | NA | NA | NA | -- |
| Selenium | ug/l | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | **13** | NA | NA | NA | NA | NA | -- |

*Notes:*

< The compound was not detected above this quantitation limit.
* Draft Annual Monitoring Report for SWMU 17 McDonnell Douglas, Hazelwood, Missouri Facility, January 25, 2002, Harding ESE, Inc.
-- ITL has not been established.
J Value qualified as an estimate.
E Actual value is known to be greater than the upper calibration range.

Shaded values indicate constituent concentrations which exceed the ITLs.

Table 6-6
**Detected Constituent Concentrations for SWMU-17 Groundwater Samples**
**(Eastern Portion of Unit)**
**McDonnell Douglas RFI**

| CONSTITUENT | UNITS | MW9S | | | | | | | MW10S | | | | MW11S | | | | MW11D | | | | INVESTIGATION THRESHOLD LEVEL (ITL)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Feb '01 | July '01 | July '01 Dup | Oct '01 | Oct '01 Dup | Dec '01 | Dec '01 Dup | Feb '01 | July '01 | Oct '01 | Dec '01 | Feb '01 | July '01 | Oct '01 | Dec '01 | Feb '01 | July '01 | Oct '01 | Dec '01 | |
| ***Volatile Organics*** | | | | | | | | | | | | | | | | | | | | | |
| 1,1-Dichloroethane | ug/l | <1 | <1 | <1 | <1 | <1 | <50 | 1.1 | <1 | <1 | <1,000 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | *4,000* |
| 1,2,4-Trimethylbenzene | ug/l | <1 | <1 | <1 | <1 | <1 | <50 | <1 | <1 | <1 | <1,000 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | -- |
| Benzene | ug/l | 4.3 | 3.9 | 3.6 | 5.2 | 5 | 51 | 4 | <1 | <1 | <1,000 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | *5* |
| Ethylbenzene | ug/l | <1 | <1 | <1 | 1.4 | 1.4 | <50 | 1.6 | <1 | <1 | <1,000 | <1 | <1 | <2 | <1 | <1 | <1 | <1 | <1 | <1 | *700* |
| Isopropyl Benzene | ug/l | 7.6 | 4.4 | 4 | 3.5 | 3.7 | <50 | 6.3 | <1 | <1 | <1,000 | 2.7 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | -- |
| Methyl Tert-Butyl Ether | ug/l | <5 | <1 | <1 | <1 | <1 | <50 | <1 | <5 | <1 | <1,000 | <1 | <5 | <1 | <1 | <1 | <5 | <1 | <1 | <1 | *400* |
| Naphthalene | ug/l | <1 | <1 | 1.4 | <1 | <1 | <50 | <1 | <1 | <1 | <3,000 | <1 | <1 | <1 | <3 | <1 | <1 | <1 | <1 | <1 | -- |
| N-Butylbenzene | ug/l | <1 | 3.9 | 2.6 | 2.7 | 2.2 | <50 | 5.3 | <1 | <1 | 3,600 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | -- |
| N-Propylbenzene | ug/l | 11 | 5.2 | 4.1 | 3.8 | 4.4 | <50 | 7.4 | <1 | <1 | <1,000 | 4 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | -- |
| P-Isopropyltoluene | ug/l | <1 | 1.5 | 1.2 | 4.2 | 4.3 | <50 | 4.4 | <1 | <1 | <1,000 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | -- |
| Sec-Butylbenzene | ug/l | 3.6 | 2 | 1.7 | 2.8 | 3.3 | <50 | 5.4 | <1 | <1 | 2,100 | 8.5 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | -- |
| Tert-Butylbenzene | ug/l | <1 | <1 | <1 | 3.2 | 3.2 | <50 | 1.9 | <1 | <1 | <1,000 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | -- |
| Tetrachloroethene | ug/l | <1 | <1 | <1 | <1 | <1 | <50 | <1 | <1 | <1 | <1,000 | <1 | <1 | 29 | <1 | <1 | <1 | <1 | <1 | <1 | *5* |
| Toluene | ug/l | <1.2 | <5 | <5 | <5 | <5 | <250 | <5 | <1 | <5 | <5,000 | <5 | <1 | <5 | <5 | <5 | <1 | <5 | <5 | <5 | *1,000* |
| Trichloroethene | ug/l | <1 | 1.2 | 1 | <1 | <1 | 52 | <1 | <1 | <1 | <1,000 | <1 | <1 | 8.9 | <1 | <1 | <1 | <1 | 17 | 1.3 | *5* |
| Xylenes, Total | ug/l | <5.2 | <3 | <3 | 4.1 | 4.3 | <150 | 5.5 | <3 | <3 | <3,000 | <3 | <3 | <3 | <3 | <3 | <3 | <3 | <3 | <3 | *10,000* |
| ***TPH*** | | | | | | | | | | | | | | | | | | | | | |
| Diesel (C7-C26) | ug/l | 2,400 | NA | NA | NA | NA | NA | NA | 950 | NA | NA | NA | <100 | NA | NA | NA | <100 | NA | NA | NA | -- |
| Miscellaneous TPH | ug/l | <100 | NA | NA | NA | NA | NA | NA | <100 | NA | NA | NA | <100 | NA | NA | NA | <100 | NA | NA | NA | -- |
| TPH (GC/FID) Low Fraction | ug/l | <100 | NA | NA | NA | NA | NA | NA | <100 | NA | NA | NA | <100 | NA | NA | NA | <100 | NA | NA | NA | *10,000* |
| TPH (GC/FID) High Fraction | ug/l | NA | 6,300 | 5,500 | 6,100 | 6,100 | 6,700J | 6,300 | NA | 7,600 | 300,000 | 330,000J | NA | <100 | <100 | <100 | NA | <100 | <100 | <100 | *10,000* |

| CONSTITUENT | UNITS | MW-11I | | | | TP 3 | | | | TP-6 | | TP-7 | TP-12 | TP-13 | TP-15 | TP-16 | INVESTIGATION THRESHOLD LEVEL (ITL)* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Feb '01 | July '01 | Oct '01 | Dec '01 | Feb '01 | July '01 | Oct '01 | Dec '01 | Sept '01 | Dec '01 | Sept '01 | Sept '01 | Sept '01 | Sept '01 | Sept '01 | |
| ***Volatile Organics*** | | | | | | | | | | | | | | | | | |
| 1,1-Dichloroethane | ug/l | <1 | <1 | <1 | <1 | <100 | <1 | <1 | <1 | <1,000 | <100 | <1,000 | <1 | <1 | <5,000 | <50 | *4,000* |
| 1,2,4-Trimethylbenzene | ug/l | <1 | <1 | <1 | <1 | 330 | <1 | 1.6 | <1 | <1,000 | <100 | <1,000 | <1 | <1 | <5,000 | <50 | -- |
| Benzene | ug/l | <1 | <1 | <1 | <1 | 680 | <1 | <1 | <1 | <1,000 | <100 | <1,000 | <1 | <1 | <5,000 | <50 | *5* |
| Ethylbenzene | ug/l | <1 | <1 | <1 | <1 | 200 | <2 | <1 | <1 | <1,000 | <100 | <1,000 | <1 | <1 | <5,000 | <50 | *700* |
| Isopropyl Benzene | ug/l | <1 | <1 | <1 | <1 | <100 | 4.7 | 3.6 | 3.4 | <1,000 | <100 | <1,000 | <1 | <1 | <5,000 | 120 | -- |
| Methyl Tert-Butyl Ether | ug/l | <1 | <1 | <1 | <1 | 1,400 | <1 | <1 | <1 | <1,000 | <100 | <1,000 | <1 | <1 | <10,000 | <100 | *400* |
| Naphthalene | ug/l | <1 | <1 | <1 | <1 | 540 | <1 | <3 | <1 | <5,000 | <100 | <5,000 | <1 | <1 | <5,000 | <50 | -- |
| N-Butylbenzene | ug/l | <1 | <1 | <1 | <1 | <100 | <1 | 12 | 12 | <1,000 | <100 | <1,000 | <1 | <1 | <5,000 | 570 | -- |
| N-Propylbenzene | ug/l | <1 | <1 | <1 | <1 | <100 | 4.2 | 3.5 | 3.2 | <1,000 | <100 | <1,000 | <1 | <1 | <5,000 | 200 | -- |
| P-Isopropyltoluene | ug/l | <1 | <1 | <1 | <1 | <100 | <1 | 2.2 | 2.9 | <1,000 | <100 | <1,000 | <1 | <1 | <5,000 | <50 | -- |
| Sec-Butylbenzene | ug/l | <1 | <1 | <1 | <1 | <100 | 10 | 6.1 | 8.4 | <1,000 | <100 | <1,000 | <1 | <1 | <5,000 | 410 | -- |
| Tert-Butylbenzene | ug/l | <1 | <1 | <1 | <1 | <100 | <1 | <1 | <1 | <1,000 | <100 | <1,000 | <1 | <1 | <5,000 | <50 | -- |
| Tetrachloroethene | ug/l | <1 | <1 | <1 | <1 | <100 | <1 | <1 | <1 | <1,000 | <100 | <1,000 | <1 | <1 | <5,000 | <50 | *5* |
| Toluene | ug/l | <5 | <5 | <5 | <5 | 1,200 | <5 | <5 | <5 | <5,000 | <500 | <5,000 | <5 | <5 | <25,000 | <250 | *1,000* |
| Trichloroethene | ug/l | <2 | <2 | <2 | <2 | <100 | <1 | <1 | <1 | <1,000 | 2,900 | <1,000 | <1 | <1 | <5,000 | <50 | *5* |
| Xylenes, Total | ug/l | <3 | <3 | <3 | <3 | 1,200 | <3 | <3 | <3 | <3,000 | <300 | <3,000 | <3 | <3 | <15,000 | <150 | *10,000* |
| ***TPH*** | | | | | | | | | | | | | | | | | |
| Diesel (C7-C26) | ug/l | NA | NA | NA | NA | 45,000 | NA | NA | NA | 230,000 | NA | 1,000,000 | <100 | <100 | <100,000 | <100,000 | -- |
| Miscellaneous TPH | ug/l | NA | NA | NA | NA | <1,000 | NA | NA | NA | <10,000 | NA | <100,000 | <100 | <100 | 2,200,000 | 2,100,000 | -- |
| TPH (GC/FID) Low Fraction | ug/l | NA | NA | NA | NA | 21,000E | NA | NA | NA | NA | NA | NA | <100 | <100 | NA | NA | *10,000* |
| TPH (GC/FID) High Fraction | ug/l | <100 | <100 | <100 | <100 | NA | 7,400 | 6,900 | 15,000J | NA | 20,000J | NA | 430 | 590 | NA | NA | *10,000* |

*Notes:*

< The compound was not detected above this quantitation limit.
* Draft Annual Monitoring Report for SWMU 17 McDonnell Douglas, Hazelwood, Missouri Facility, January 25, 2002, Harding ESE, Inc.
-- ITL has not been established.
J Value qualified as an estimate.
E Actual value is known to be greater than the upper calibration range.

Shaded values indicate constituent concentrations which exceed the ITLs.

## TABLE 6-7

## Maximum Constituent Concentrations for SWMU 17 Groundwater Samples McDonnell Douglas RFI

| CONSTITUENT | UNITS | Maximum Conc (1) | INVESTIGATION THRESHOLD LEVEL (ITL) (2) | Max Conc EXCEED ITL? |
|---|---|---|---|---|
| **Volatile Organics** | | | | |
| Acetone | ug/l | 55 | 4,000 | NO |
| **Benzene** | ug/l | **680** | 5 | **YES** |
| 1,1-Dichloroethane | ug/l | 11 | 4,000 | NO |
| **1,1-Dichloroethene** | ug/l | **180** | 7 | **YES** |
| **cis-1,2-Dichloroethene** | ug/l | **97,000** | 70 | **YES** |
| **trans-1,2-Dichloroethene** | ug/l | **150** | 100 | **YES** |
| Ethylbenzene | ug/l | 200 | 700 | NO |
| **Methylene chloride** | ug/l | **9** | 5 | **YES** |
| **Perchloroethene** | ug/l | **490,000** | 5 | **YES** |
| **Toluene** | ug/l | **25,000** | 1,000 | **YES** |
| **1,1,2-Trichloroethane** | ug/l | **290** | 5 | **YES** |
| **Trichloroethene** | ug/l | **270,000** | 5 | **YES** |
| **Vinyl chloride** | ug/l | **50,000** | 2 | **YES** |
| Xylenes, Total | ug/l | 1,200 | 10,000 | NO |
| Benzene Derivatives | ug/l | 1,300 | NA | NA |
| **MTBE** | ug/l | **1,400** | 400 | **YES** |
| Total Purgeable Hydrocarbons | mg/l | 5 | 10 | NO |
| **Total Extractable Hydrocarbons** | mg/l | **2,200** | 10 | **YES** |

Table 6-8 Results of Field and Laboratory Groundwater Parameter Measurement, SWMU No. 17

| East | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Parameters | Units | Method | MW-9S | | | | MW-10S | | | | MW-11D | | | | MW-11I | | | | MW-11S | | | | TP-3 | | | |
| | | | 21-Feb-01 | 27-Jul-01 | 30-Oct-01 | 19-Dec-01 | 20-Feb-01 | 27-Jul-01 | 29-Oct-01 | 19-Dec-01 | 19-Feb-01 | 26-Jul-01 | 26-Oct-01 | 17-Dec-01 | 19-Feb-01 | 26-Jul-01 | 26-Oct-01 | 17-Dec-01 | 20-Feb-01 | 25-Jul-01 | 29-Oct-01 | 17-Dec-01 | 23-Feb-01 | 25-Jul-01 | 29-Oct-01 | 19-Dec-01 |
| pH | stu | field | 6.85 | 6.88 | 6.88 | 6.95 | 6.61 | 6.83 | 6.95 | 6.91 | 6.31 | 6.61 | 6.68 | 6.67 | 6.62 | 6.7 | 6.77 | 6.73 | 6.39 | 6.6 | 6.5 | 6.65 | NA | 6.5 | NA | 6.86 |
| Conductivity | uS/cm | field | 2,600 | 2,380 | 2,320 | 2,280 | 1,980 | 2,010 | 1,915 | 2,020 | 806 | 805 | 850 | 821 | 921 | 849 | 839 | 829 | 587 | 6,100 | 625 | 6,260 | NA | 3,200 | NA | 3,460 |
| Temperature | °C | field | 9.9 | 21.7 | 22.1 | 19.1 | 14 | 20.7 | 23.5 | 19.5 | 17.4 | 24 | 17.1 | 10.4 | 18.6 | 24.5 | 17.5 | 16.6 | 15.2 | 23 | 24.3 | 20.4 | NA | 26 | NA | 18.8 |
| Dissolved Oxygen | mg/L | field | 0.54 | 0.35 | 0.32 | 0.12 | NA | NA | NA | NA | 4.27 | 1.18 | 0.87 | 0.68 | 3.04 | 1.52 | 0.25 | 0.8 | NA | NA | NA | NA | NA | NA | NA | NA |
| Iron II | mg/L | field | 4.8 | NA | 5.4 | 2.6 | NA | NA | NA | NA | 0.4 | 0.4 | NA | NA | 0.2 | 0.2 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| ORP | mV | field | -25 | -142 | -150 | -112 | NA | NA | NA | NA | 34 | 244 | 10 | NA | 20 | 220 | 18 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Alkalinity | mg/L | field | NA | NA | NA | NA | NA | NA | NA | NA | >1000 | NA | NA | NA | 480 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Chloride | ug/L | lab | 580,000 | 460,000 | 390,000 | 340,000 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Dissolved Organic Carbon | ug/L | lab | 19,000 | 18,000 | 20,000 | 17,000 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Nitrate | ug/L | lab | 450 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Nitrate-Nitrite | ug/L | lab | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Sulfate | ug/L | lab | 9,500 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Total Organic Carbon | ug/L | lab | 20,000 | 22,000 | 23,000 | 22,000 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

| West | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Parameters | Units | Method | MW-5I | | | | MW-6S | | | | MW-7S | | | | TP-1 | TP-2 | | | | TP-5 | | |
| | | | 22-Feb-01 | 27-Jul-01 | 26-Oct-01 | 18-Dec-01 | 22-Feb-01 | 27-Jul-01 | 26-Oct-01 | 19-Dec-01 | 22-Feb-01 | 27-Jul-01 | 30-Oct-01 | 13-Dec-01 | 23-Feb-01 | 23-Feb-01 | 25-Jul-01 | 30-Oct-01 | 18-Dec-01 | 23-Feb-01 | 27-Jul-01 | 30-Oct-01 |
| pH | stu | field | 6.71 | 6.61 | 6.68 | 6.65 | 6.77 | 6.8 | 6.86 | 6.92 | 6.48 | 6.4 | 6.43 | 6.52 | NA | NA | 7.4 | 7.16 | 7.38 | NA | 6.66 | 6.68 |
| Conductivity | uS/cm | field | 930 | 910 | 933 | 938 | 2,060 | 2,030 | 2,110 | 2,090 | 3,670 | 3,550 | 3,710 | 3,690 | NA | NA | 930 | 1,426 | 1,499 | NA | 3,990 | 3,860 |
| Temperature | °C | field | 12 | 19.4 | 18.2 | 18 | 14.6 | 24.7 | 22.5 | 21.7 | 17 | 26 | 25.3 | 22.5 | NA | NA | 24 | 23.3 | 17.3 | NA | 26.1 | 24 |
| Dissolved Oxygen | mg/L | field | 0.66 | 0.77 | 0.14 | 0.24 | 0.61 | NA | NA | NA | 0.96 | 0.46 | 0.93 | 0.3 | NA | NA | NA | NA | NA | NA | NA | NA |
| Iron II | mg/L | field | 5.2 | 4 | 5.3 | 5.2 | 3.8 | NA | NA | NA | 0 | 0.6 | 0.8 | 0.9 | NA | NA | NA | NA | NA | NA | NA | NA |
| ORP | mV | field | -18 | -81 | -99 | -88 | -33 | NA | NA | NA | -31 | 43 | 119 | 53 | NA | NA | NA | NA | NA | NA | NA | NA |
| Alkalinity | mg/L | field | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Chloride | ug/L | lab | 17,000 | 16,000 | 12,000 | 12,000 | NA | NA | NA | NA | NA | 930,000 | 1,100,000 | 1,000,000 | NA | NA | NA | NA | NA | NA | NA | NA |
| Dissolved Organic Carbon | ug/L | lab | 5,000 | 4,600 | 3,500 | 5,600 | NA | NA | NA | NA | NA | 2,000 | 1,100 | 1,700 | NA | NA | NA | NA | NA | NA | NA | NA |
| Nitrate | ug/L | lab | 400 | 170 | NA | NA | NA | NA | NA | NA | NA | 190 | 770 | 380 | NA | NA | NA | NA | NA | NA | NA | NA |
| Nitrate-Nitrite | ug/L | lab | 400 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Sulfate | ug/L | lab | 13,000 | 9200 | 6400 | 6600 | NA | NA | NA | NA | NA | 98000 | 110000 | 110000 | NA | NA | NA | NA | NA | NA | NA | NA |
| Total Organic Carbon | ug/L | lab | 5,000 | 5,800 | 3,900 | 5,800 | NA | NA | NA | NA | NA | 2,200 | 1,200 | 2,400 | NA | NA | NA | NA | NA | NA | NA | NA |

| South | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Parameters | Units | Method | MW-8I | | | | MW-8S | | | | TP-4 | | | |
| | | | 20-Feb-01 | 26-Jul-01 | 26-Oct-01 | 18-Dec-01 | 20-Feb-01 | 26-Jul-01 | 29-Oct-01 | 13-Dec-01 | 21-Feb-01 | 26-Jul-01 | 30-Oct-01 | 18-Dec-01 |
| pH | stu | field | 7.28 | 6.88 | 6.98 | 6.78 | 6.81 | 6.51 | 6.52 | 6.61 | 10.3 | 9.6 | 9.63 | 9.82 |
| Conductivity | uS/cm | field | 606 | 795 | 905 | 911 | 1,788 | 1,669 | 1,448 | 1,278 | 3,070 | 1,260 | 1,227 | 848 |
| Temperature | °C | field | 17.9 | 22.3 | 9.9 | 18 | 15.6 | 23.2 | 24 | 18.4 | 14.3 | 26.2 | 23.4 | 19.4 |
| Dissolved Oxygen | mg/L | field | 4.23 | 0.23 | 3.62 | 0.52 | 2.79 | 1.29 | 3.16 | 0.23 | NA | NA | NA | NA |
| Iron II | mg/L | field | 0.6 | 1.6 | NA | NA | 0.4 | 0 | NA | 0 | NA | NA | NA | NA |
| ORP | mV | field | 61 | -37 | 75 | -14 | 10 | 191 | 190 | 169 | NA | NA | NA | NA |
| Alkalinity | mg/L | field | 240 | NA | NA | NA | 240 | NA | NA | NA | NA | NA | NA | NA |
| Chloride | ug/L | lab | NA | NA | NA | NA | 380,000 | 21,000 | 16,000 | 13,000 | NA | NA | NA | NA |
| Dissolved Organic Carbon | ug/L | lab | NA | NA | NA | NA | 2,600 | 2,600 | 2,200 | 2,100 | NA | NA | NA | NA |
| Nitrate | ug/L | lab | NA | NA | NA | NA | 140000 | 130000 | 95000 | 77000 | NA | NA | NA | NA |
| Nitrate-Nitrite | ug/L | lab | NA | NA | NA | NA | 150000 | 2300 | NA | NA | NA | NA | NA | NA |
| Sulfate | ug/L | lab | NA | NA | NA | NA | 130,000 | 140000 | 110000 | 100000 | NA | NA | NA | NA |
| Total Organic Carbon | ug/L | lab | NA | NA | NA | NA | 2,200 | 2,900 | 2,300 | 2,500 | NA | NA | NA | NA |

| Notes |
|---|
| stu = standard units |
| uohms/cm = microhms per centimeter |
| °C = degrees Celsius |
| mg/L = milligrams per liter |
| mV = millivolt |
| ug/L = micrograms per liter |
| |
| NA = Not analyzed |

Table 6-9 Preliminary Screening for Anaerobic Biodegradation Processes, SWMU No. 17

| Analysis | Units | East | West | | South |
|---|---|---|---|---|---|
| | | MW-9S | MW-5I | MW-7S | MW-8S |
| Oxygen | mg/L | 0.3325 | 0.4525 | 0.6625 | 1.8675 |
| Value | | 3 | 3 | 0 | 0 |
| Nitrate | mg/L | 0.4500 | 0.2850 | 0.4467 | 0.1105 |
| Value | | 2 | 2 | 2 | 2 |
| Iron II | mg/L | 4.2667 | 4.925 | 0.575 | 0.1333 |
| Value | | 3 | 3 | 0 | 0 |
| Sulfate | mg/L | 9.5000 | 8.8000 | 106.0000 | 120.0000 |
| Value | | 2 | 2 | 0 | 0 |
| Sulfide | mg/L | NA | NA | NA | NA |
| Value | | | | | |
| Methane | mg/L | NA | NA | NA | NA |
| Value | | | | | |
| ORP | mV | -107.25 | -71.5 | 46 | 140 |
| Value | | 2 | 1 | 1 | 0 |
| pH | stu | 6.89 | 6.6625 | 6.4575 | 6.6125 |
| Value | | 0 | 0 | 0 | 0 |
| TOC | mg/L | 21.7500 | 5.1250 | 1.9333 | 2.4750 |
| Value | | 2 | 0 | 0 | 0 |
| Temperature | °C | 18.2 | 16.9 | 22.7 | 20.3 |
| Value | | 0 | 0 | 1 | 1 |
| Carbon Dioxide | | NA | NA | NA | NA |
| Value | | | | | |
| Alkalinity | mg/L | NA | NA | NA | 240 |
| Value | | | | | 0 |
| Chloride | mg/L | 442.5000 | 14.2500 | 1010.0000 | 107.5000 |
| Value | | 2 | 0 | 2 | 2 |
| Hydrogen | nM | NA | NA | NA | NA |
| Value | | | | | |
| Volatile Fatty Acids | mg/L | NA | NA | NA | NA |
| Value | | | | | |
| BTEX | mg/L | <0.1 | ND | ND | ND |
| Value | | 0 | 0 | 0 | 0 |
| Tetrachloroethene | | ND | Yes | Yes | Yes |
| Value | | 0 | 0 | 0 | 0 |
| Trichloroethene* | | Yes | Yes | Yes | ND |
| Value | | 0 | 2 | 2 | 0 |
| DCE* | | ND | Yes | Yes | ND |
| Value | | 0 | 2 | 2 | 0 |
| Vinyl Chloride* | | ND | Yes | ND | ND |
| Value | | 0 | 2 | 0 | 0 |
| 1,1,1-Trichloroethane | | ND | ND | ND | ND |
| Value | | 0 | 0 | 0 | 0 |
| DCA | | ND | ND | ND | ND |
| Value | | 0 | 0 | 0 | 0 |
| Carbon Tetrachloride | | ND | ND | ND | ND |
| Value | | 0 | 0 | 0 | 0 |
| Chloroethane | | ND | ND | ND | ND |
| Value | | 0 | 0 | 0 | 0 |
| Ethene/Ethane | mg/L | NA | NA | NA | NA |
| Value | | | | | |
| Chloroform | | ND | ND | ND | ND |
| Value | | 0 | 0 | 0 | 0 |
| Dichloromethane | | ND | ND | ND | ND |
| Value | | 0 | 0 | 0 | 0 |
| Value Totals | | 16 | 17 | 10 | 5 |

Notes:
* Points only awarded for these compounds if the compound is a daughter product
stu - standard units
°C - degrees Celsius
mg/L - milligrams per liter
mV - millivolt

**Table 6-9 (continued) Preliminary Screening for Anaerobic Biodegradation Processes, SWMU No. 17**

| Score | Interpretation |
|---|---|
| 0 to 5 | Inadequate evidence for anaerobic biodegradation* of chlorinated organics |
| 6 to 14 | Limited evidence for anaerobic biodegradation* of chlorinated organics |
| 15 to 20 | Adequate evidence for anaerobic biodegradation* of chlorinated organics |
| >20 | Strong evidence for anaerobic biodegradation* of chlorinated organics |

* reductive dechlorination

Source: Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water EPA/600/R-98/128

Table 6-10 Groundwater Level Measurements, SWMU 17, McDonnell Douglas RFI

February 2001

| Well ID | Date | Depth toWater (ft) | Groundwater Elevation (msl) |
|---|---|---|---|
| MW-10S | 2/20/01 | 6.73 | 541.04 |
| MW-11D | 2/19/01 | 23.87 | 523.17 |
| MW-11I | 2/19/01 | 7.69 | 539.39 |
| MW-11S | 2/20/01 | 6.22 | 540.99 |
| MW-5I | 2/22/01 | 6.87 | 540.86 |
| MW-6S | 2/22/01 | 4.92 | 542.92 |
| MW-7S | 2/22/01 | 3.66 | 543.72 |
| MW-8I | 2/20/01 | 9.63 | 538.21 |
| MW-8S | 2/20/01 | 6.9 | 540.95 |
| MW-9S | 2/21/01 | 4.79 | 542.32 |
| TP-1 | 2/23/01 | 3.84 | 544.00 |
| TP-2 | 2/23/01 | 3.98 | |
| TP-3 | 2/23/01 | 6.03 | 542.49 |
| TP-4 | 2/21/01 | 2.82 | |
| TP-5 | 2/23/01 | 3.88 | 544.00 |

July 2001

| Well ID | Date | Depth toWater (ft) | Groundwater Elevation (msl) |
|---|---|---|---|
| MW-10S | 7/27/01 | 7.31 | 540.46 |
| MW-11D | 7/26/01 | 21.15 | 525.89 |
| MW-11I | 7/26/01 | 6.61 | 540.47 |
| MW-11S | 7/25/01 | 6.67 | 540.54 |
| MW-5I | 7/27/01 | 6.52 | 541.21 |
| MW-6S | 7/27/01 | 4.58 | 543.26 |
| MW-7S | 7/27/01 | 2.78 | 544.60 |
| MW-8I | 7/26/01 | 7.87 | 539.97 |
| MW-8S | 7/26/01 | 6.01 | 541.84 |
| MW-9S | 7/27/01 | 4.29 | 542.82 |
| TP-2 | 7/25/01 | 3.54 | |
| TP-3 | 7/25/01 | 5.77 | 542.75 |
| TP-4 | 7/26/01 | 1.97 | |
| TP-5 | 7/27/01 | 3.06 | 544.82 |

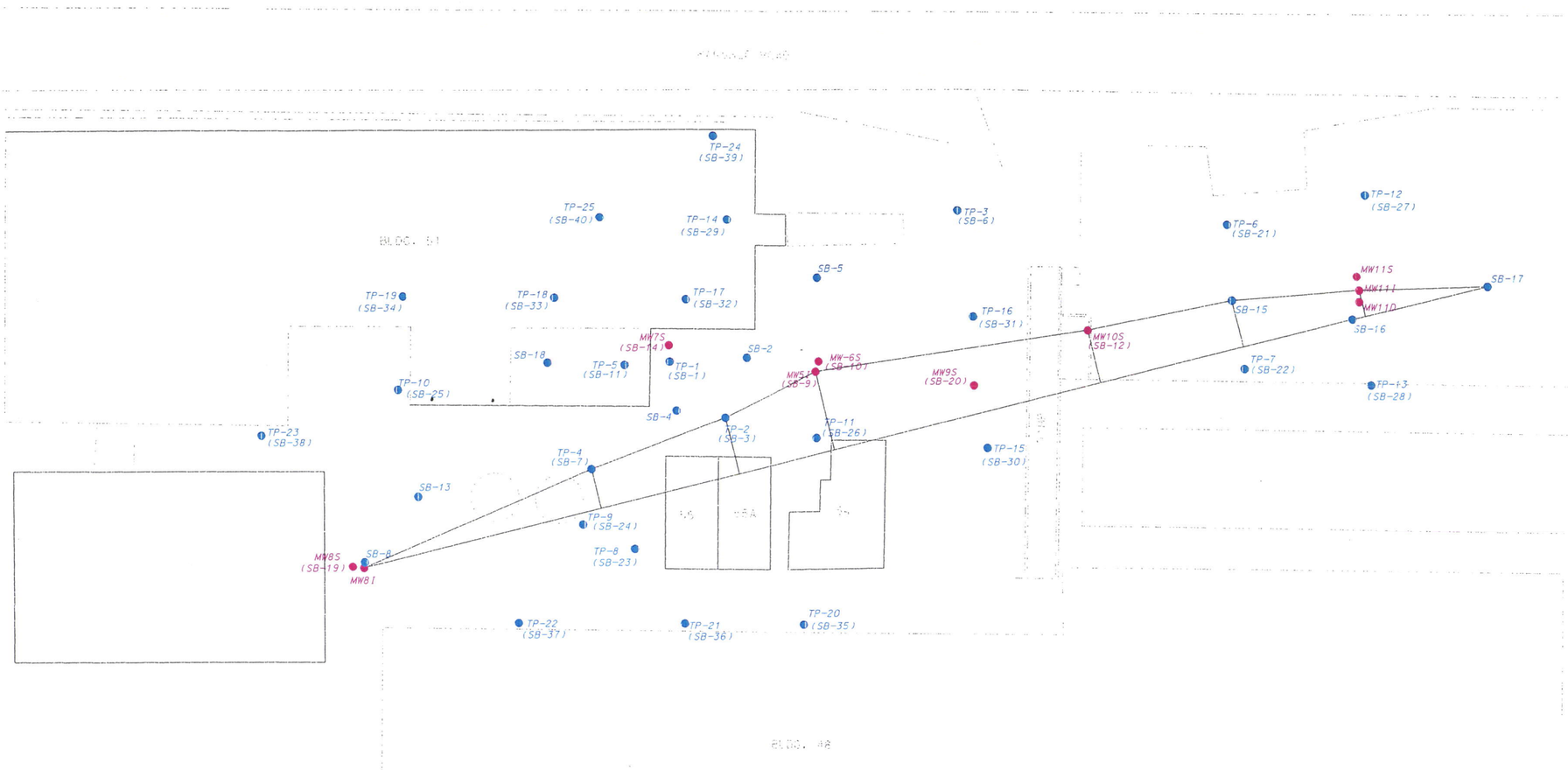
# Table 6-10 Groundwater Level Measurements, SWMU 17, McDonnell Douglas RFI

October 2001

| Well ID | Date | Depth toWater (ft) | Groundwater Elevation (msl) |
|---|---|---|---|
| MW-10S | 10/29/01 | 6.9 | 540.87 |
| MW-11D | 10/26/01 | 21.25 | 525.79 |
| MW-11I | 10/26/01 | 6.67 | 540.41 |
| MW-11S | 10/29/01 | 7.57 | 539.64 |
| MW-5I | 10/26/01 | 6.99 | 540.74 |
| MW-6S | 10/26/01 | 5.42 | 542.42 |
| MW-7S | 10/30/01 | 2.68 | 544.70 |
| MW-8I | 10/26/01 | 7.89 | 539.95 |
| MW-8S | 10/29/01 | 6.4 | 541.45 |
| MW-9S | 10/30/01 | 4.37 | 542.74 |
| TP-2 | 10/30/01 | 3.49 | |
| TP-3 | 10/29/01 | 5.95 | 542.57 |
| TP-4 | 10/30/01 | 1.83 | |
| TP-5 | 10/30/01 | 2.97 | 544.91 |

December 2001

| Well ID | Date | Depth toWater (ft) | Groundwater Elevation (msl) |
|---|---|---|---|
| MW-10S | 12/19/01 | 6.71 | 541.06 |
| MW-11D | 12/17/01 | 21.4 | 525.64 |
| MW-11I | 12/17/01 | 6.52 | 540.56 |
| MW-11S | 12/17/01 | 5.39 | 541.82 |
| MW-5I | 12/18/01 | 6.85 | 540.88 |
| MW-6S | 12/19/01 | 4.17 | 543.67 |
| MW-7S | 12/13/01 | 2.31 | 545.07 |
| MW-8I | 12/18/01 | 8.06 | 539.78 |
| MW-8S | 12/13/01 | 8.62 | 539.23 |
| MW-9S | 12/19/01 | 3.91 | 543.20 |
| TP-2 | 12/18/01 | 2.16 | |
| TP-3 | 12/19/01 | 4.99 | 543.53 |
| TP-4 | 12/18/01 | 1.31 | |




LEGEND

- MONITORING WELL
- Geoprobe Boring and/or Temporary Piezometer

SCALE 1"=40'

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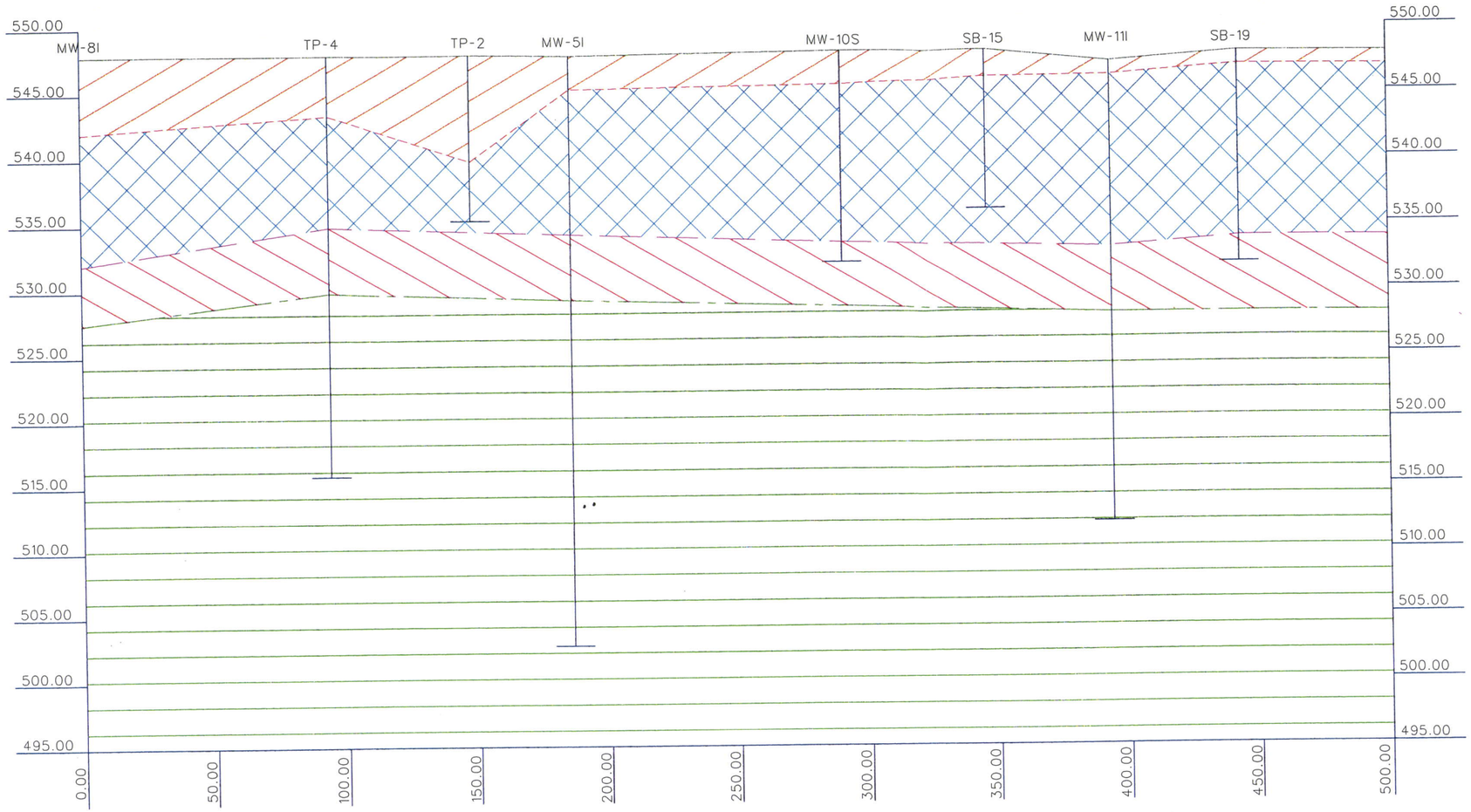
## Figure 6-1
## Cross-Section Location for SWMU No. 17


**Harding ESE**
A MACTEC Company
3199 Riverport Tech Center Drive
St. Louis, MO 63043
314-209-5900




LEGEND

| | | |
|---|---|---|
| Fill | - | Mixed, previously disturbed materials: gravel, asphalt and clay |
| Silty Clay | - | Gray-brown to red-brown, soft to stiff |
| Silt | - | Dark reddish-brown, medium stiff, slightly moist |
| Clay | - | Dark gray, to stiff to very stiff plastic clay. Occasional soft wet clay zones noted in SB-9 |

SCALE
VERT. 1"=20'
HORZ. 1"=50'

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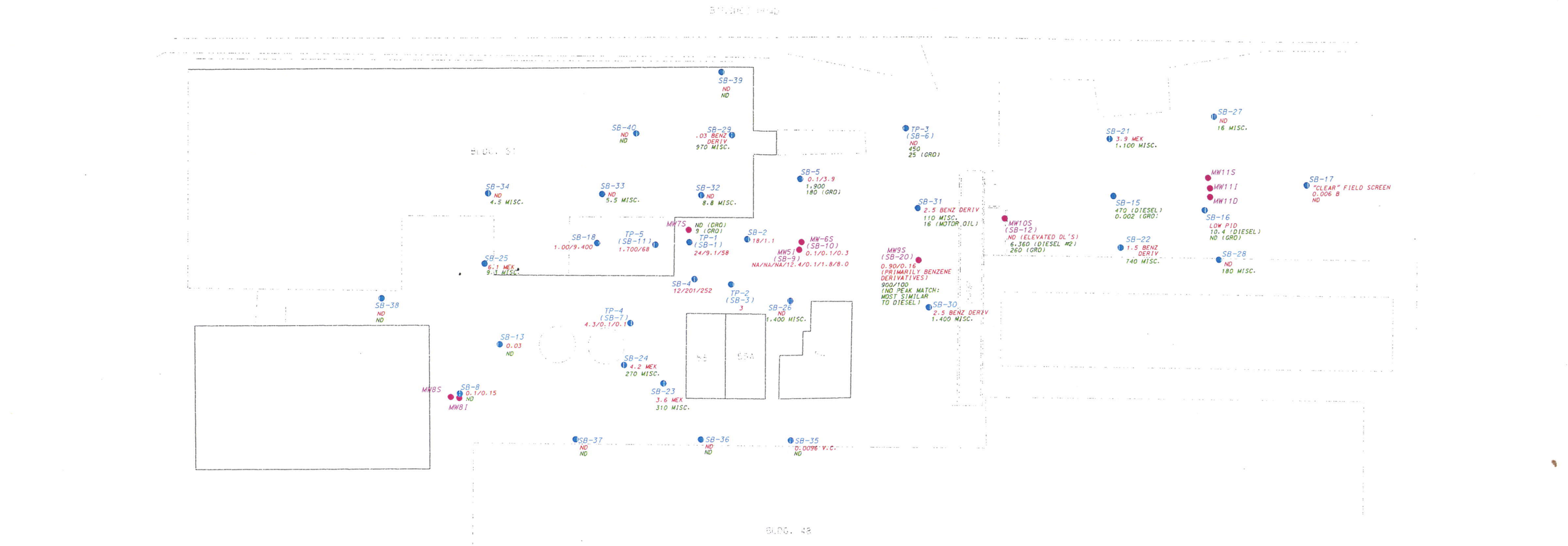
Figure 6-2
Cross-Section for SWMU No. 17

Harding ESE
A MACTEC Company
3199 Riverport Tech Center Drive
St. Louis, MO 63043
314-209-5900




N

W E

S

SCALE 1"=40'

LEGEND

- MONITORING WELL
- Geoprobe Boring and/or Temporary Piezometer
- 5.4 TOTAL VOCs IN SOIL (mg/kg)
- 450 TPH IN SOIL (mg/kg)

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Figure 6-3

VOC and TPH Concentrations in Soil for SWMU No. 17


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314-209-5900


P:/5197042/DGN/SWMU 17/Figure_6-4.dgn 1/22/02

# THE BOEING COMPANY

## Figure 6-4 ( February 2001 )

## VOC and TPH Concentrations in Groundwater for SWMU No. 17

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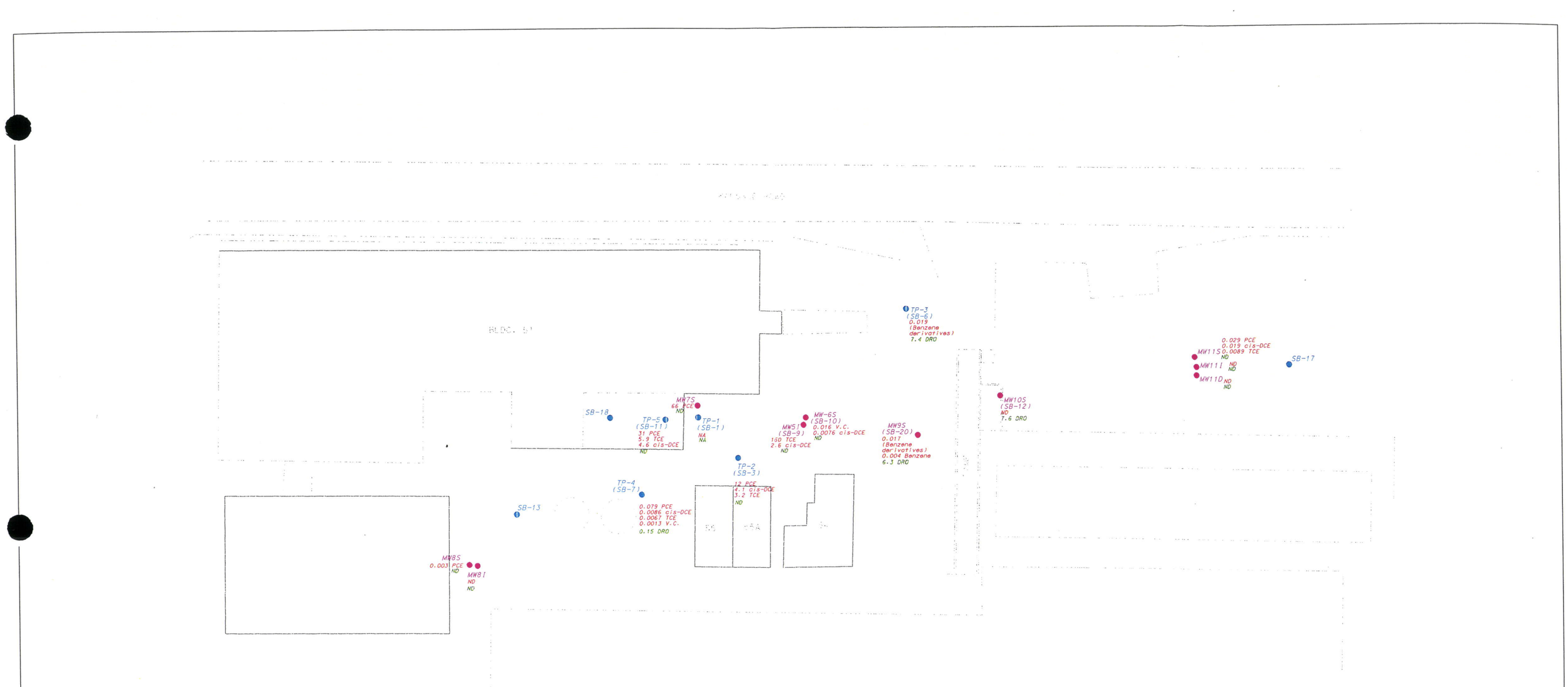
St. Louis, MO 63043
314-209-5900




LEGEND

- MONITORING WELL
- Geoprobe Boring and/or Temporary Piezometer
- 5.4 VOCs IN GROUNDWATER (mg/l)
- 450 TPH IN GROUNDWATER (mg/l)

# THE BOEING COMPANY

## Figure 6-5 (July 2001)
## VOC and TPH Concentrations in Groundwater for SWMU No. 17

**Harding ESE**
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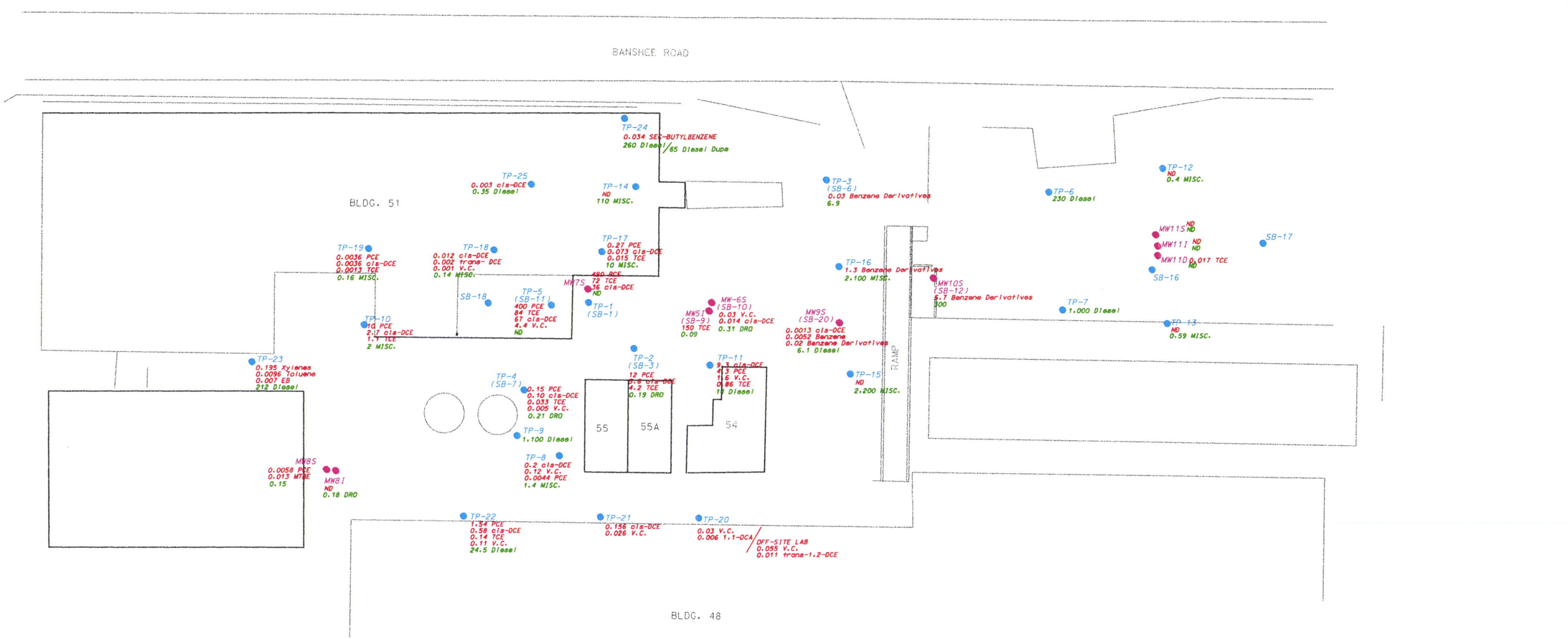
St. Louis, MO 63043
314-209-5900




SCALE 1"=40'

LEGEND

- MONITORING WELL
- Geoprobe Boring and/or Temporary Piezometer
- 5.4 VOCs IN GROUNDWATER (mg/l)
- 450 TPH IN GROUNDWATER (mg/l)

P:/5197042/DGN/SHEET/Figure_6-6.dgn 1/22/02

# THE BOEING COMPANY

## Figure 6-6 (September/October 2001)
## VOC and TPH Concentrations in Groundwater for SWMU No. 17


**Harding ESE**
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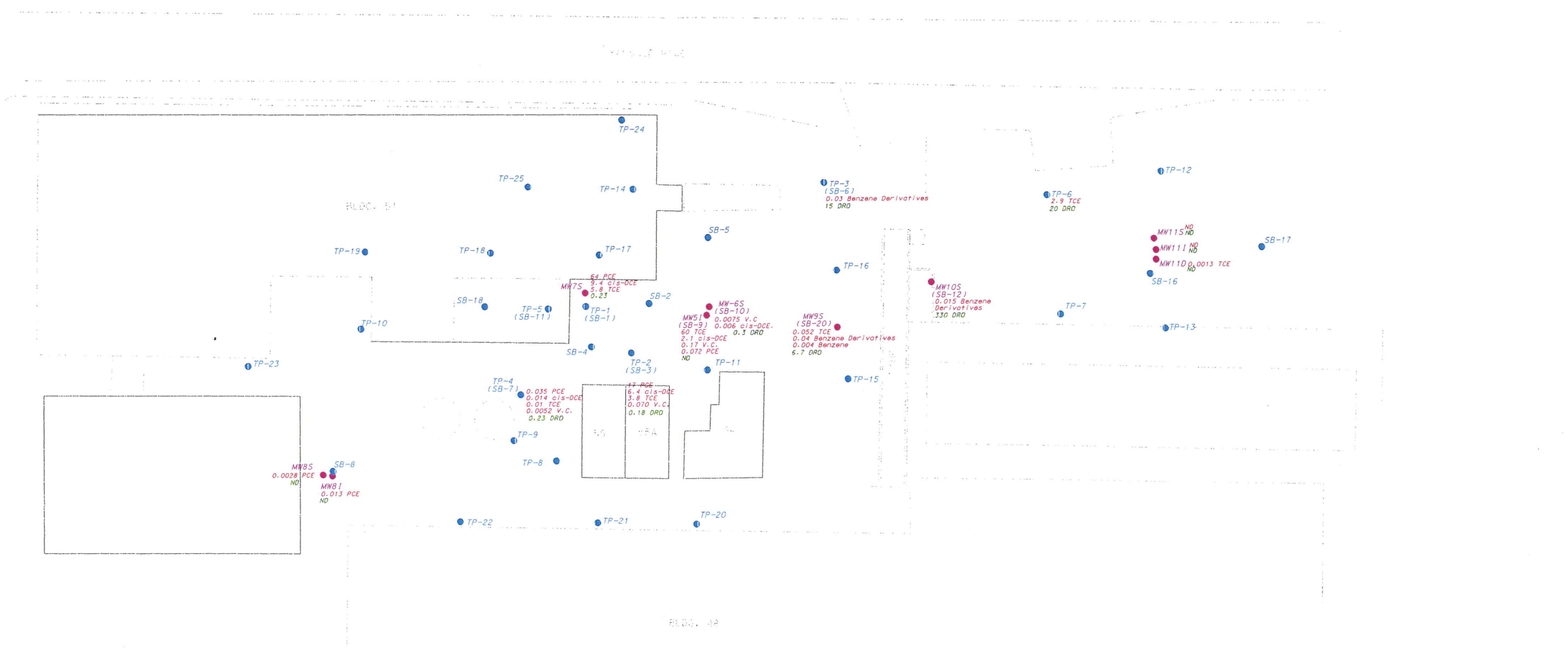
3199 Riverport Tech Center Drive
St. Louis, MO 63043
314-209-5900




SCALE 1"=40'

LEGEND

- MONITORING WELL
- Geoprobe Boring and/or Temporary Piezometer
- 5.4 VOCs IN GROUNDWATER (mg/l)
- 450 TPH IN GROUNDWATER (mg/l)

# THE BOEING COMPANY

## Figure 6-7 (December 2001)
## VOC and TPH Concentrations in Groundwater for SWMU No. 17


**Harding ESE**
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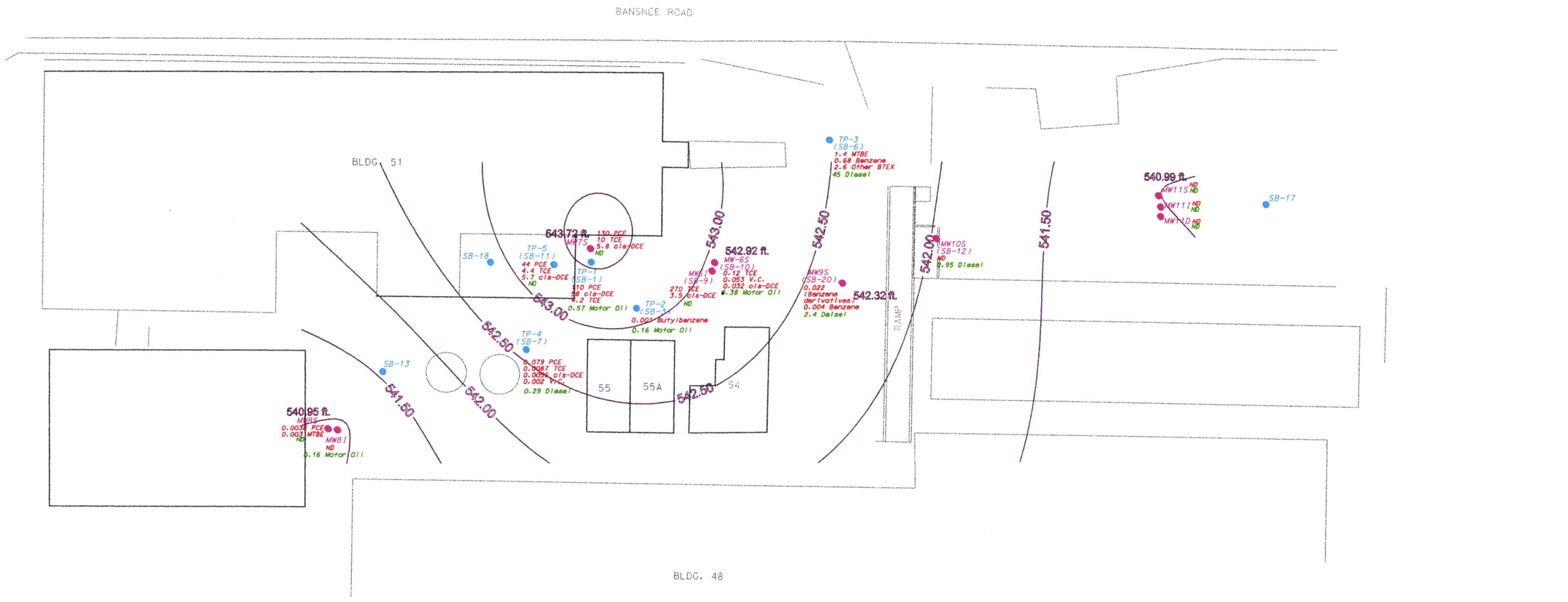
St. Louis, MO 63043
314-209-5900




LEGEND

- MONITORING WELL
- Geoprobe Boring and/or Temporary Piezometer
- 5.4 VOCs IN GROUNDWATER (mg/l)
- 450 TPH IN GROUNDWATER (mg/l)
- -540- GROUNDWATER ISOPLETH CONTOURS

SCALE 1"=40'

P:/519704Z/DGN/SH/Figure_6-8.dgn 1/22/02

# THE BOEING COMPANY

## Figure 6-8

Shallow Groundwater Elevation Contours for SWMU No. 17 (February 2001)


**Harding ESE**
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3199 Riverport Tech Center Drive
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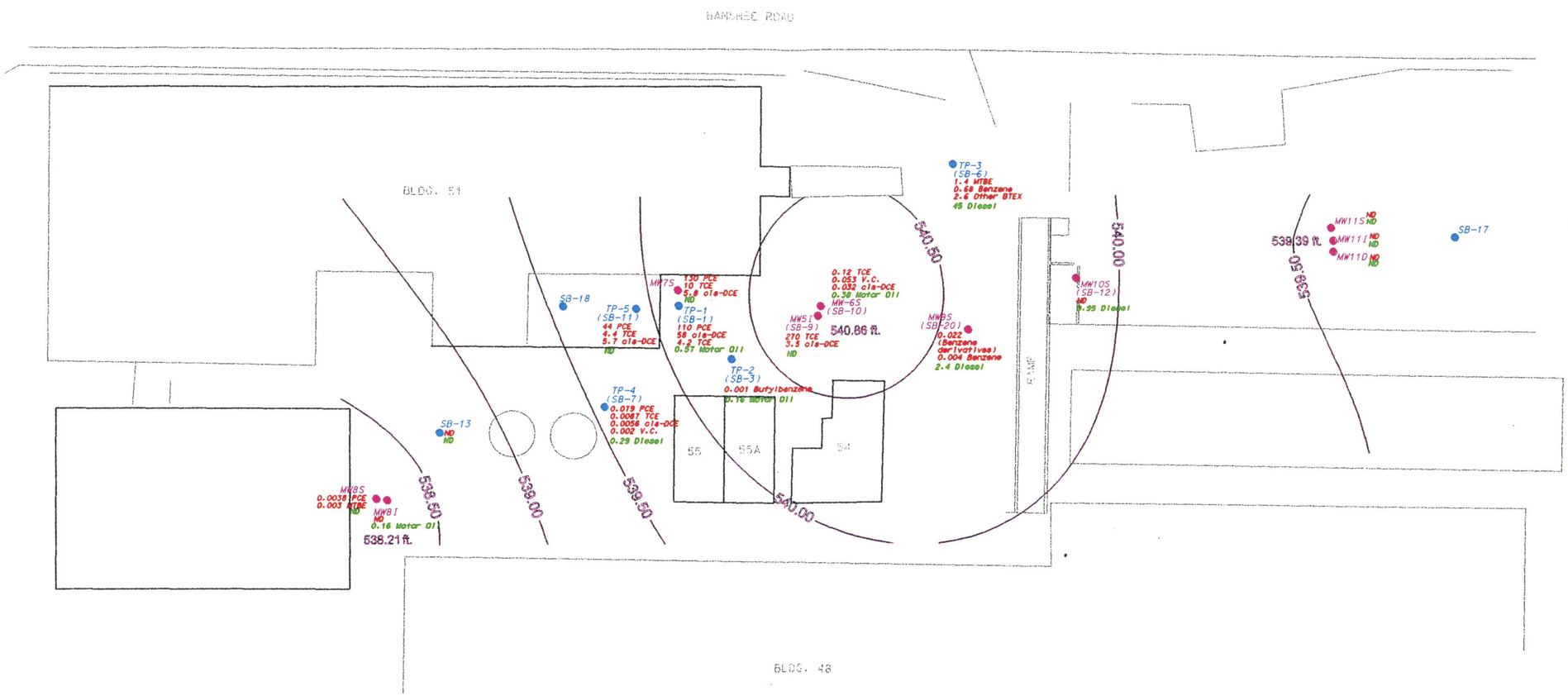
314-209-5900




SCALE 1"=40'

LEGEND

- MONITORING WELL
- Geoprobe Boring and/or Temporary Piezometer
- 5.4 VOCs IN GROUNDWATER (mg/l)
- 450 TPH IN GROUNDWATER (mg/l)
- —540— GROUNDWATER ISOPLETH CONTOURS

# THE BOEING COMPANY

## Figure 6-9

Intermediate Groundwater Elevation Contours for SWMU No. 17 ( February 2001 )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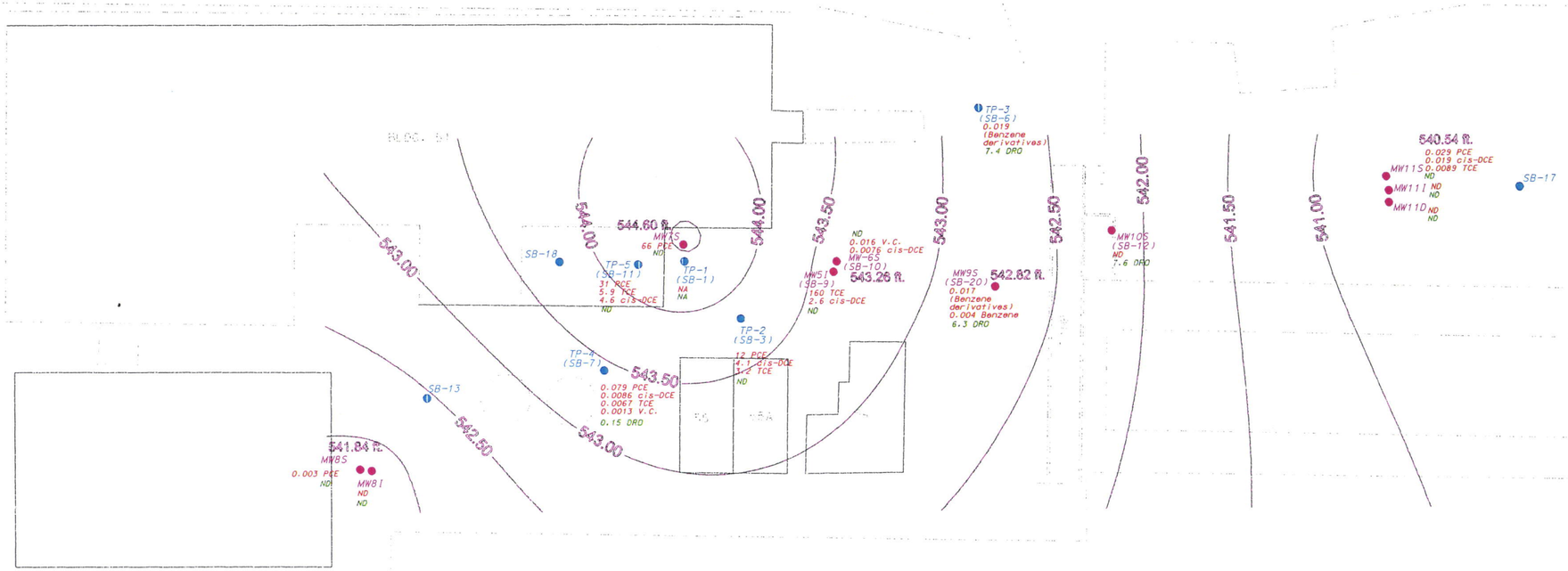
314-209-5900


P:/5197042/DGN/SHT Figure_6-9.dgn 1/22/02




SCALE 1"=40'

LEGEND

- MONITORING WELL
- Geoprobe Boring and/or Temporary Piezometer
- 5.4 VOCs IN GROUNDWATER (mg/l)
- 450 TPH IN GROUNDWATER (mg/l)
- —540— GROUNDWATER ISOPLETH CONTOURS

# THE BOEING COMPANY

Figure 6-10

Shallow Groundwater Elevation Contours for SWMU No. 17 (July 2001)


**Harding ESE**

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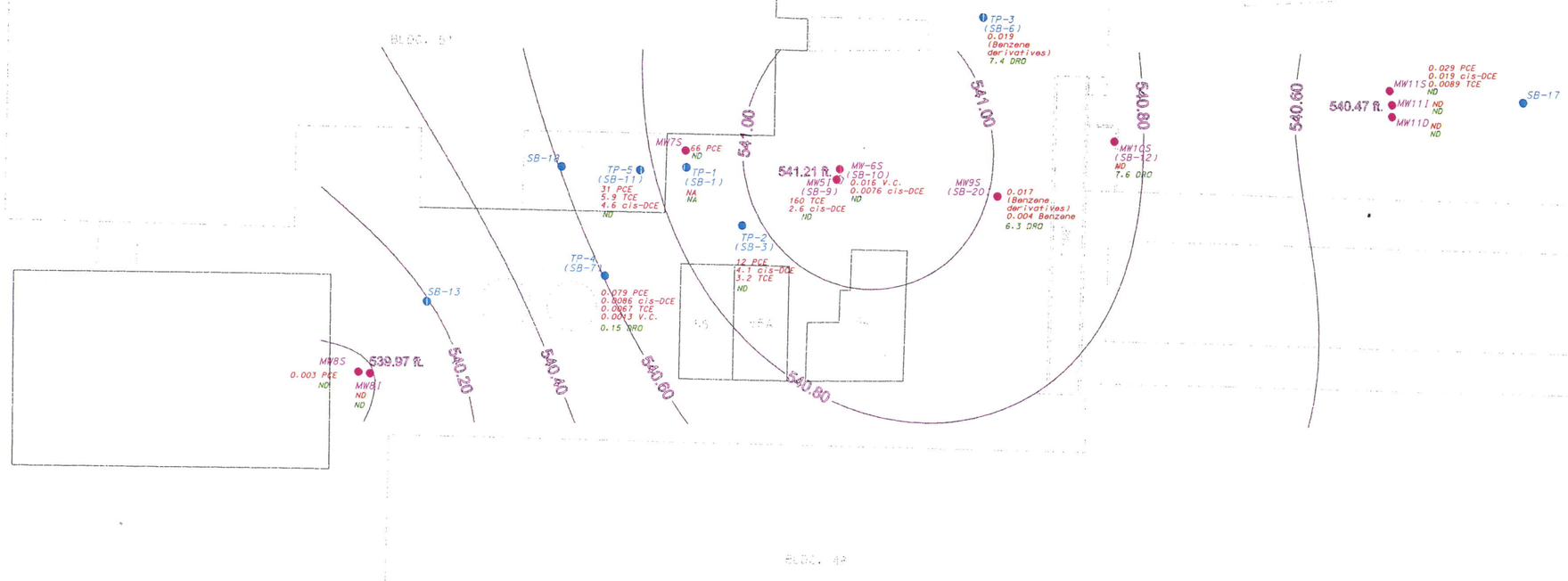
St. Louis, MO 63043

314-209-5900




SCALE 1"=40'

LEGEND

- MONITORING WELL
- Geoprobe Boring and/or Temporary Piezometer
- 5.4 VOCs IN GROUNDWATER (mg/l)
- 450 TPH IN GROUNDWATER (mg/l)
- --540-- GROUNDWATER ISOPLETH CONTOURS

# THE BOEING COMPANY

Figure 6-11

Intermediate Groundwater Elevation Contours for SWMU No. 17 (July 2001)


**Harding ESE**

A MACTEC Company

3199 Riverport Tech Center Drive

St. Louis, MO 63043

314-209-5900

BANSHEE ROAD

BLDG. 54

BLDG. 48

TP-24
0.034 SEC-BUTYLBENZENE
260 Diesel/65 Diesel Dupe

TP-25
0.003 cis-DCE
0.35 Diesel

TP-14
ND
110 MISC.

TP-3
(SB-6)
0.03 Benzene Derivatives
6.9

TP-12
ND
0.4 MISC.

TP-6
230 Diesel

MW11S ND
MW11I ND
MW11D ND
539.84 ft.

SB-17

SB-16

TP-19
0.0036 PCE
0.0038 cis-DCE
0.0013 TCE
0.16 MISC.

TP-18
0.012 cis-DCE
0.008 trans- DCE
0.001 V.C.
0.14 MISC.

TP-17
0.27 PCE
0.075 cis-DCE
0.013 TCE
10 MISC.

544.70 ft.
MW7S
420 PCE
72 TCE
36 cis-DCE
10

SB-18

TP-5
(SB-11)
400 PCE
84 TCE
67 cis-DCE
4.4 V.C.
ND

TP-1
(SB-1)

544.00

543.50

543.00

542.42 ft.
MW-6S
(SB-10)
0.01 V.C.
0.011 cis-DCE
0.31 DRO

MW5I
(SB-9)
250 TCE
0.09

542.74 ft.
MW9S
(SB-20)
0.0013 cis-DCE
0.0052 Benzene
0.02 Benzene Derivatives
6.1 Diesel

TP-16
1.3 Benzene Derivatives
2,100 MISC.

MW10S
(SB-12)
6.7 Benzene Derivatives
800

541.00

540.50

540.00

TP-7
1,000 Diesel

TP-13
ND
0.59 MISC.

TP-10
10 PCE
1.7 cis-DCE
1.7 TCE
2 MISC.

TP-23
0.195 Xylenes
0.0096 Toluene
0.007 EB
212 Diesel

TP-4
(SB-7)
0.15 PCE
0.10 cis-DCE
0.033 TCE
0.005 V.C.
0.21 DRO

TP-2
(SB-3)
12 PCE
4.8 cis-DCE
4.2 TCE
0.19 DRO

TP-11
9.1 cis-DCE
4.3 PCE
1.6 V.C.
0.86 TCE
19 Diesel

TP-15
ND
2,200 MISC.

RAMP

542.00

541.50

542.50

TP-9
1,100 Diesel

55A

54

TP-8
0.2 cis-DCE
0.12 V.C.
0.0044 PCE
1.4 MISC.

541.45 ft.
MW8S
0.0058 PCE
0.013 MTBE
0.15

MW8I
ND
0.18 DRO

TP-22
1.34 PCE
0.58 cis-DCE
0.14 TCE
0.11 V.C.
24.5 Diesel

TP-21
0.156 cis-DCE
0.026 V.C.

TP-20
0.03 V.C.
0.008 1,1-DCA

OFF-SITE LAB
0.055 V.C.
0.011 trans-1,2-DCE

SCALE 1"=40'

LEGEND

- MONITORING WELL
- Geoprobe Boring and/or Temporary Piezometer
- 5.4 VOCs IN GROUNDWATER (mg/l)
- 450 TPH IN GROUNDWATER (mg/l)
- —540— GROUNDWATER ISOPLETH CONTOURS

H:\SIM\042\GIS\SHE\figure_6-12.dgn 1/22/02

# THE BOEING COMPANY

## Figure 6-12

Shallow Groundwater Elevation Contours for SWMU No. 17 (October 2001)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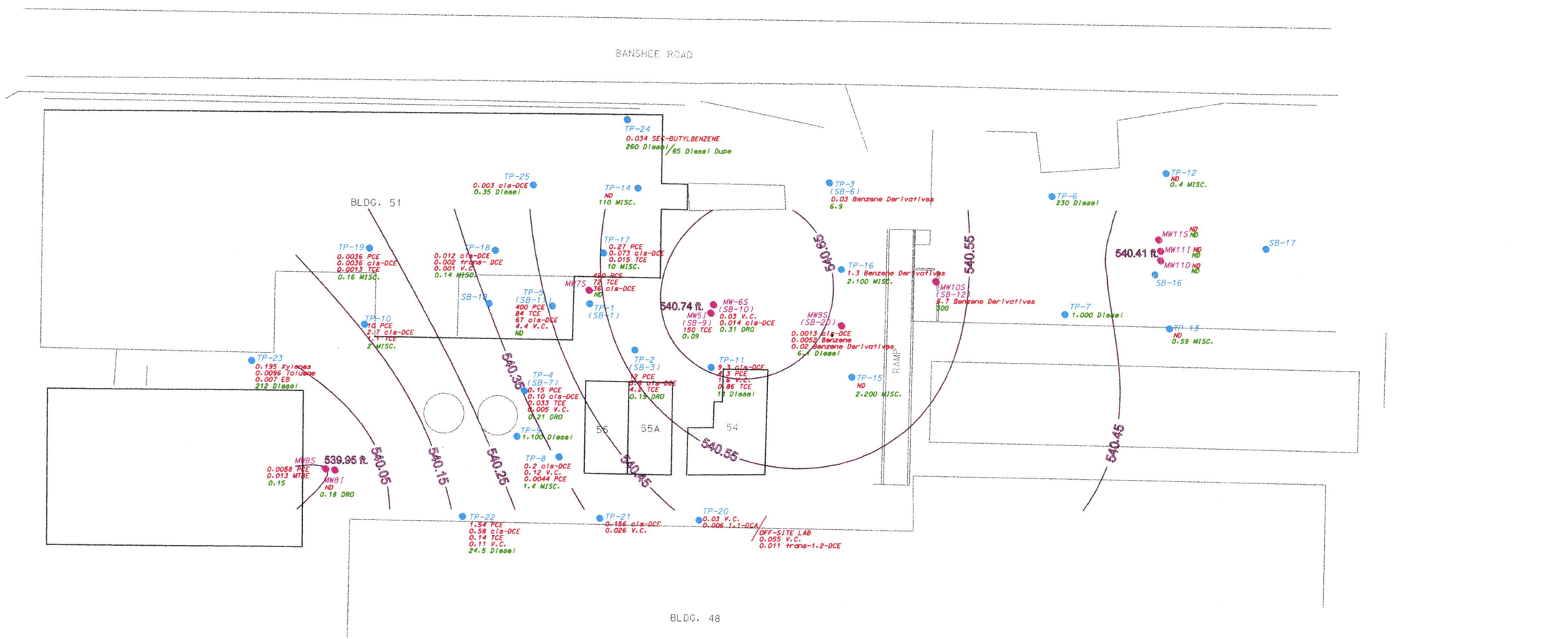
St. Louis, MO 63043
314-209-5900




N

W E

SCALE 1"=40'

LEGEND

- MONITORING WELL
- Geoprobe Boring and/or Temporary Piezometer
- 5.4 VOCs IN GROUNDWATER (mg/l)
- 450 TPH IN GROUNDWATER (mg/l)
- —540— GROUNDWATER ISOPLETH CONTOURS

P:/5197042/DGN/SHEET/Figure_6-13.dgn 1/22/02

# THE BOEING COMPANY

## Figure 6-13
## Intermediate Groundwater Elevation Contours for SWMU No. 17 (October 2001)


**Harding ESE**
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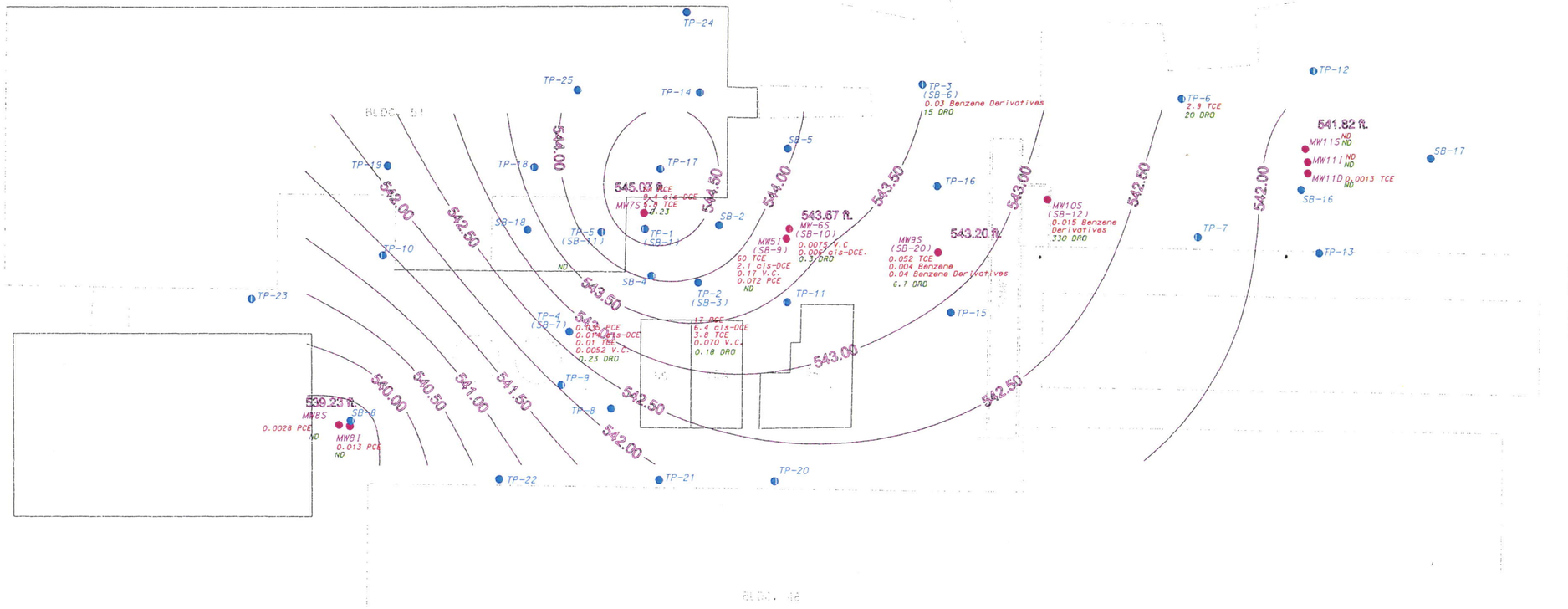
3199 Riverport Tech Center Drive
St. Louis, MO 63043
314-209-5900

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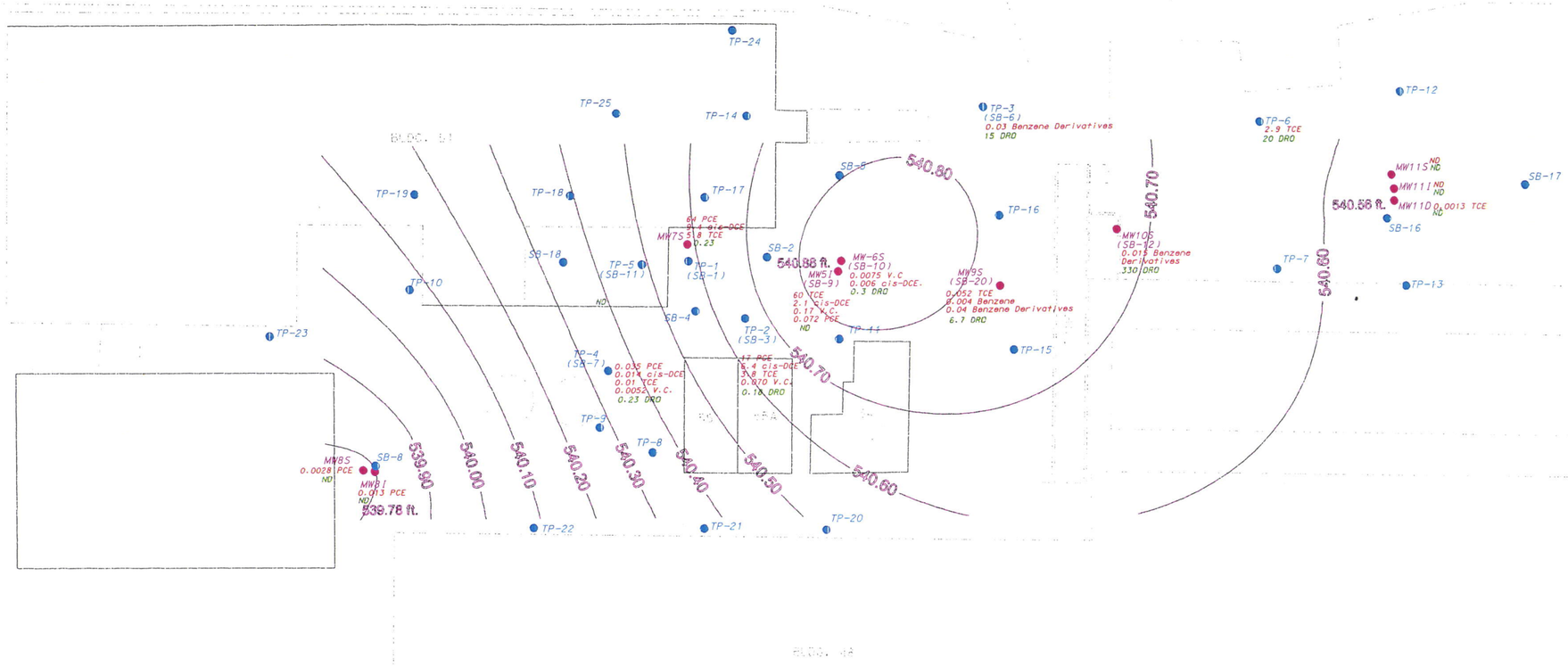
## Figure 6-14
## Shallow Groundwater Elevation Contours for SWMU No. 17 (December 2001)


Harding ESE
A MACTEC Company
3199 Riverport Tech Center Drive
St. Louis, MO 63043
314-209-5900




SCALE 1"=40'

LEGEND

- MONITORING WELL
- Geoprobe Boring and/or Temporary Piezometer
- 5.4 VOCs IN GROUNDWATER (mg/l)
- 450 TPH IN GROUNDWATER (mg/l)
- —540— GROUNDWATER ISOPLETH CONTOURS

# THE BOEING COMPANY

Figure 6-15

Intermediate Groundwater Elevation Contours for SWMU No. 17 (December 2001)


**Harding ESE**

A MACTEC Company

3199 Riverport Tech Center Drive

St. Louis, MO 63043

314-209-5900

# 7.0 SUMMARY AND CONCLUSIONS

By integrating the results from the initial investigation activities completed in 1998-2000 with the results from the supplemental monitoring activities performed in 2001, this section presents media-specific summaries and conclusions for SWMU No. 17. In addition, recommendations for future Corrective Action are provided.

Supplemental RFI field investigation/monitoring tasks were conducted at SWMU No. 17 to further 1) characterize the nature and extent of any potential hazardous waste/constituent releases to soil, 2) assess the nature and extent of similar releases to groundwater, and 3) evaluate the groundwater surface beneath this unit.

## 7.1 Summary of Soil Results for SWMU No. 17

Through the utilization of investigative soil borings, PID field screening, and soil analyses, the nature and horizontal extent of impacted soils at SWMU No. 17 was more thoroughly defined. As a result, two potential source areas of impacted soil were identified. One area contains solvent-related VOCs (PCE and various degradation products), while the other area contains fuel and/or gasoline related TPH. Using ITLs as a comparative baseline, approximate delineation of constituent impacts to subsurface soils is displayed in Figure 7-1.

The highest VOC (and PCE) concentrations were detected at soil boring locations within the most interior portions of the unit (SB-1, SB-2, SB-3, SB-4, SB-11, and SB-18). Soil samples from SB-18, SB-11, SB-4, and SB-1 exhibited the highest PCE concentrations of 9,300 ppm, 1,700 ppm, 240 ppm, and 58 ppm, respectively. Delineation of VOC-impacted soils was confirmed based on results in the unsaturated zone for soil samples from SB-34, SB-25, and SB-13 to the west; SB-33 and SB-32 to the north; SB-5 and SB-10 to the east; SB-24, SB-23, and SB-26 to the south.

Selected soil samples were also analyzed for other non-RCRA related parameters. Free product was noted within the shallow fill material at SB-20. The highest TPH concentrations were detected for soil samples from the saturated unit along the eastern portion of the unit (SB-5, SB-6, SB-12, SB-15, SB-20, SB-21, SB-22, SB-30, and SB-31). Soil samples from the saturated unit for SB-12, SB-5, SB-30, and SB-21 exhibited the highest TPH concentrations of 6,360 ppm diesel, 1,900 ppm, 1,400 ppm, and 1,100 ppm, respectively. TPH concentrations were also detected for soil samples from the saturated unit along the southern portion of the unit (310 ppm at SB-23 and 270 ppm at SB-24). Delineation of TPH-impacted soils was confirmed based on results in the unsaturated zone for soil samples from SB-40 , SB-33, SB-25, and SB-8 to the west; SB-27, SB-16, and SB-28 to the east; SB-37, SB-36, and SB-35 to the south.

Analytical results for SWMU No. 17 soil samples indicated that the most impacted intervals corresponded with materials in the saturated zone (groundwater table typically ranged from 1-6 ft bls at this SWMU). As a result, a significant portion of the noted soil impacts are attributable to the very shallow nature of the groundwater table at SWMU No. 17.

Acetone and methylene chloride were not detected in any of the samples collected from SWMU No. 17 in 2000-01. The low acetone and methylene chloride concentrations detected in 1998 are likely to represent a laboratory artifact, as opposed to an accurate representation of soil conditions at the unit.

Analytical results for the soil samples collected from SWMU No. 17 indicated that six VOC constituents exceeded their respective ITLs. In addition, three other VOCs (benzene, 1,1-DCE, and vinyl chloride) exceeded the corresponding ITL values for groundwater. As a result, the following soil-associated COCs at SWMU No. 17 will be retained for evaluation in the follow-up risk assessment:

- VOCs (9): cis-1,2-DCE, trans-1,2-DCE, PCE, 1,1,2-trichloroethane, TCE, 2-butanone, benzene, 1,1-DCE, and vinyl chloride; and
- TPH (1): TPH extractables.

Using the soil constituent concentrations detected at SWMU No. 17, the follow-up risk assessment will evaluate potential health risks that exist for selected exposure scenarios. As stated in previous reports, a significant portion of the soil impacts are best addressed as groundwater issues due to the very shallow nature of the groundwater table at SWMU No. 17.

## 7.2 Summary of Groundwater Results for SWMU No. 17

Through the utilization of investigative soil borings, groundwater elevation measurements, pump tests, and groundwater analyses, the nature and horizontal extent of impacted groundwater at SWMU No. 17 was more thoroughly defined. As a result, two slightly overlapping areas of impacted groundwater were identified. One area contains solvent-related VOCs (PCE and various degradation products), while the other area contains fuel and/or gasoline-related TPH. Using ITLs as a comparative baseline, approximate delineation of constituent impacts to groundwater soils is displayed in Figure 7-2.

### 7.2.1 Groundwater Flow Direction and Gradient

Groundwater elevation measurements were utilized to evaluate the direction and flowrate of shallow groundwater beneath SWMU No. 17. All of the 2001 quarterly groundwater surface maps demonstrate bi-directional flow of groundwater to the east (toward Coldwater Creek) and to the south. Low flow gradients are also indicated.

### 7.2.2 Hydraulic Conductivity

Given the lateral extent of constituents detected in the groundwater and low flow characteristics observed in all of the shallow monitoring wells except MW-7S, the overall horizontal hydraulic conductivity for the site is estimated as closer to the values reported for glacial till of $1 \times 10^{-5}$ - $1 \times 10^{-6}$ cm/sec.

Geotechnical lab results for vertical hydraulic conductivity ranged from $7.1 \times 10^{-6}$ cm/sec for a sample collected from 9-11 ft bls (Silty Clay Unit) to $1.1 \times 10^{-9}$ cm/sec for a sample collected from 59-60 ft bls (Clay Unit). These lab results indicate that vertical hydraulic conductivity decreases with depth. The low vertical permeability of this Clay Unit provides a degree of vertical hydraulic separation from the underlying bedrock.

### 7.2.3 Chemical Analysis

VOCs in Groundwater

Groundwater analytical results were utilized to further characterize and delineate the extent of groundwater impacts at SWMU No. 17. Sixteen (16) VOCs were detected in groundwater samples collected within or adjacent to SWMU No. 17. Six of the sampling locations which exhibited the highest VOC concentrations were situated within and immediately downgradient to the east of the unit (MW-7S, MW-5I, TP-5, TP-1, TP-2, and TP-11). Groundwater samples from MW-7S, TP-5, and MW-5I exhibited the highest total VOC concentrations of 598 ppm (October 2001), 555 ppm (October 2001), and 274 ppm (February 2001), respectively. Delineation of an upgradient boundary was established to the west and north of SWMU No. 17 where VOCs detected from TP-23, TP-19, TP-18, TP-14, and TP-24 were less than the corresponding ITLs. Similarly, a downgradient boundary was established to the east where VOCs detected from TP-12, MW-11S, MW-11I, MW-11D, SB-17, and TP-13 have generally been less than the corresponding ITLs.

PCE and several degradation products including TCE, cis-1,2-DCE, and vinyl chloride were detected at the highest concentrations. Groundwater samples from MW-7S and TP-5 exhibited the highest PCE concentrations of 490 ppm (October 2001) and 400 ppm (October 2001), respectively. The sample from TP-5 also contained the highest cis-1,2-DCE level of 67 ppm (October 2001). Located approximately 70 feet downgradient (east) from MW-7S, the groundwater sample from MW-5I exhibited the highest TCE concentration of 270 ppm (February 2001).

Significantly elevated VOC concentrations were also detected at various locations along the southern portion of the unit (TP-4, TP-22, TP-21, TP-8). Groundwater samples from TP-4 and TP-22 exhibited the highest PCE concentrations of 17 ppm (April 1998) and 1.54 ppm (October 2001), respectively. TP-22 is situated near the collection point for a concrete stormwater drainage basin to the south of the caustic tanks.

Solvent-related VOCs (PCE and TCE) were detected along the far eastern portion of the area. A groundwater sample from TP-6 exhibited the highest TCE concentrations of 2.9 ppm (December 2001).

In addition to the previous descriptions of solvent-related VOCs, gasoline/fuel-related VOCs (BTEX, MTBE, benzene derivatives) were also detected immediately to the east (downgradient) of SWMU No. 17. Free product was observed at MW-9S. Groundwater samples from TP-3, TP-16, and MW-9S exhibited the highest gasoline/fuel-related VOC concentrations. The February 2001 sample from TP-3 exhibited a benzene concentration of 0.68 ppm and a MTBE concentration of 1.4 ppm. Although benzene and MTBE were detected at TP-3 for the initial quarterly event, neither constituent was detected in any of the 3 subsequent quarterly monitoring events. Quarterly groundwater samples from MW-9S have exhibited detectable levels of BTEX and chlorinated VOC constituents (TCE, cis-1,2-DCE). With the exception of two benzene results (October 2001 and December 2001) and one TCE result (December 2001), the detected concentrations were less than the corresponding VOC ITLs.

Acetone and methylene chloride were not detected in any of the samples collected from SWMU No. 17 during the 2000-2001 monitoring period. The low acetone and methylene chloride concentrations detected in 1998 samples are likely to represent a laboratory artifact, as opposed to an accurate representation of groundwater conditions at SWMU No. 17.

Of the 12 groundwater sampling locations that were sampled during each of the 2001 quarterly events, two initial VOC trends were identified as follows:

- MW-6S: VOC levels for vinyl chloride, TCE, and 1,2-DCE at MW-6S have generally decreased; and
- MW-5I: TCE levels have continuously decreased over the 1-year period.

Vertical Delineation

Analytical results for the 4 intermediate/deep monitoring wells (MW-5I, MW-8I, MW-11I, and MW-11D) were evaluated to assess any potential impacts to the deeper water-bearing units at SWMU No. 17. Results for nested shallow and deeper monitoring wells were also compared.

Groundwater samples from MW-5I within the source area exhibited elevated VOC concentrations (including PCE, TCE, and cis-1,2-DCE) which exceeded the corresponding ITL values. While the detected VOC parameters for MW-6S and MW-5I were similar, concentrations were significantly higher for samples from MW-5I.

No VOCs were detected at MW-8I during the initial three quarterly events. The groundwater sample from the December 2001 quarterly event exhibited VOC concentrations of 0.013 ppm PCE and 0.027 ppm toluene. The PCE concentration exceeded the ITL of 0.005 ppm. Low levels of PCE and MTBE were detected at MW-8S throughout the 2001 monitoring period. Only the October 2001 level of 0.0058 ppm PCE exceeded the ITL.

No VOCs were detected at MW-11I during the 2001 monitoring period. Although MW-11D also exhibited primarily "non-detectable" results, isolated low levels of TCE (0.017 ppm and 0.0013 ppm) were detected at MW-11D during the October and December 2001 quarterly events, respectively. Similarly, no VOCs were detected at MW-11S during the February, October, or December 2001 quarterly events. However, groundwater samples from the July 2001 event exhibited detectable levels that exceeded ITLs (0.029 ppm PCE, 0.009 ppm TCE).

TPH in Groundwater

TPH was detected in several groundwater samples collected within or adjacent to SWMU No. 17. The sampling locations which exhibited the highest TPH concentrations were situated along the eastern portion of the unit. As previously indicated, free product has been observed at MW-9S. Groundwater samples from TP-15 (2,200 ppm), TP-16 (2,100 ppm), TP-7 (1,000 ppm diesel), MW-10S (330 ppm), TP-3 (45 ppm diesel), and TP-6 (20 ppm) also exhibited significant TPH levels. Extractable TPH levels from these 6 locations exceeded the ITL of 10 ppm.

Elevated TPH levels were also noted along the southern portion of the unit (1,100 ppm diesel at TP-9 and 24.5 ppm diesel at TP-22); the northeast corner of Building 51 (260 ppm diesel at TP-24 and 110 ppm at TP-14); and the southwest corner of Building 51 (TP-23). Extractable TPH levels from these 4 sampling locations exceeded the ITL.

Of the 12 groundwater sampling locations that were sampled during each of the 2001 quarterly events, one initial TPH trend was identified as follows:

- MW-10S: TPH levels increased over the 1-year period.

Summary of Chemical Analysis

Analytical results for the groundwater samples collected from SWMU No. 17 indicated that several constituents exceeded their respective ITLs. As a result, the following groundwater-associated COCs at SWMU No. 17 will be retained for evaluation in the follow-up risk assessment:

- VOCs (9): benzene, 1,1-DCE, cis-1,2-DCE, trans-1,2-DCE, PCE, 1,1,2-trichloroethane, TCE, vinyl chloride, and MTBE.
- TPH (1): Extractable TPH.

### 7.2.4 Field Measurements

The groundwater sample from TP-4 to the southwest of the unit exhibited the only noteworthy field parameter values. pH values in TP-4 ranged from 9.6 to 10.3 in 2001 and indicate the presence of potentially abnormal groundwater conditions at this location. Conductivity values for TP-4 ranged from 848 to 3,070 micro Siemens per centimeter (µS/cm) in 2001 which are consistent with site-wide conductivity values. The elevated conductivity of 101,000 µS/cm measured in TP-4 in 1998 appears to have been anomalous and could have been caused by turbidity following installation of the piezometer.

### 7.2.5 Biodegradation Status

Monitoring wells in the western and eastern portions of the unit (MW-5I and MW-9S) exhibited biodegradation "scoring totals" of 17 and 16, respectively. These preliminary screening results indicate that adequate evidence exists that anaerobic biodegradation of chlorinated organics is at least occurring at these two locations. Monitoring well MW-7S exhibited a scoring result of 10 which indicates that evidence of anaerobic biodegradation is limited at this location. However, scoring totals are likely to be conservatively low due to masking of VOC concentrations (e.g. daughter product concentrations at MW-7S due to significant PCE/TCE levels) and absence of data for other screening parameters (e.g. carbon dioxide, methane, etc.). There is inadequate evidence of anaerobic degradation at the southwest portion of SWMU No. 17 where a low screening total of 5 was obtained for MW-8S. This result is expected since VOC levels at this location have been either very low and/or not detected.

Based on site-specific analytical data from SWMU No. 17 (e.g. the presence of chlorinated daughter products, high ratio of cis-1,2-DCE isomer, low levels of competing anions, acceptable pH conditions, etc.), natural biodegradation (specifically anaerobic dechlorination) appears to be occurring at various locations beneath the unit.

## 7.3 Recommendations for Future Corrective Action

Based on the results of the 1998-2001 RFI activities and the conclusions of this Annual Report, MD plans to proceed with the following Corrective Action efforts at SWMU No. 17:

1) Install three shallow soil borings to the south of the Facility to further evaluate the horizontal extent of groundwater impacts along the south side of the unit. Two borings will be inside of Building 48; one approximately 30 to 50 feet to the south and west of TP-22 and one approximately 30 to 50 feet south of TP-21. One additional boring would be installed to the east of TP-20, just north of Building 48. Proposed boring locations are presented on Figure 7-3, actual boring locations will depend on accessibility and subsurface utility conflicts. Soil and groundwater ITLs used for the additional investigation will be the ITL values updated for the Tract 1 South investigation as presented in Tables 7-1 and 7-2.

One soil sample and a groundwater sample from each boring will be analyzed on-site for VOCs and TPH using a mobile laboratory. If PCE/VOC are detected above ITLs at any of these boring locations, an additional boring will be advanced at a feasible location that is further hydraulically down gradient of that location. This "step-out" process will be utilized to delineate the horizontal extent of VOC impacts, while minimizing the number of samples that are submitted for laboratory analysis. If unexpected field conditions are encountered, the Harding ESE field geologist and Boeing will discuss any recommended changes in sampling approach.

If no "step-out" borings are needed, the boring located to the east of TP-20 will be completed as a monitoring piezometer with sand pack, bentonite seal, and flush mount well box. The other borings will be abandoned in accordance with MDNR requirements. If "step-out" borings are required, one or more of the borings will be converted to monitoring piezometer(s) so as to provide adequate clean downgradient monitoring points.

2) Perform a follow-up risk assessment. These results will be used to define the extent of any source removal/excavation efforts at the unit. The results from the risk assessment will also be used to guide Corrective Action efforts for this unit including the development of risk-based soil and groundwater cleanup standards, as needed.

3) Continue with a modified groundwater monitoring program to evaluate groundwater conditions at the unit. Based on the 2001 monitoring results, the sampling schedule will be revised as presented in Table 7-3. The following issues will be evaluated during the groundwater sampling program:

I) Continue tracking isolated PCE/TCE detections at MW-11S and MW-11D along the eastern (downgradient) side of the unit. No VOCs were detected at MW-11S during the February, October, or December 2001 quarterly events. However, groundwater samples from the July 2001 event exhibited detectable levels that exceeded ITLs (0.029 ppm PCE, 0.009 ppm TCE). Although MW-11D also exhibited primarily "non-detectable" results, isolated low levels of TCE (0.017 ppm and 0.0013 ppm) were detected at MW-11D during the October and December 2001 quarterly events, respectively.

ii) Continue tracking isolated PCE detections at MW-8S and MW-8I to the west of the caustic tanks. With the exception of the October 2001 level (0.0058 ppm PCE), detected concentrations at MW-8S have been less than the corresponding VOC ITLs. Although no VOCs were detected at MW-8I during the initial three quarterly events, 0.013 ppm PCE was detected during the December 2001 quarterly event. This value exceeded the ITL.

iii) Continue tracking VOC levels at TP-6 along the far eastern portion of the area. Groundwater samples from TP-6 exhibited TCE concentrations of 2.9 ppm (December 2001) which exceeded the ITL.

iv) Upon completion, incorporate the monitoring piezometer TP-26 into the quarterly groundwater monitoring program.

v) Continue evaluating selected biodegradation parameters to determine if natural attenuation is proceeding at rates consistent with meeting any site-specific cleanup objectives. If natural attenuation is selected for implementation at SWMU No. 17, detailed lines of evidence per USEPA Monitored Natural Attenuation guidance document (OSWER Directive 9200.4-17, 1997) would be provided in the CMI to estimate natural attenuation rates.

4) Due to the widespread nature of TPH subsurface impacts and groundwater flow direction to the east and south, MD suspects that the on-site TPH impacts observed at SWMU No. 17 are not solely attributable to MD sources. MD recommends that further investigation be conducted to determine the nature and extent of hydrocarbon-related impacts associated with potential off-site sources.

5) Upon completion/approval of the RFI Report Addendum for SWMU No. 17, Boeing will prepare a Corrective Measures Study (CMS) / Corrective Measures Implementation (CMI) Workplan to define a systematic approach for evaluating potential Corrective Measures (CMs). MD anticipates evaluating 3 primary types of CMs:

- Institutional control CMs will be evaluated to address potential exposure to impacted soil and groundwater at SWMU No. 17. These CMs will focus on land development

restrictions, deed restrictions, access restrictions, drinking water restrictions, etc. as a means of minimizing/eliminating contact with impacted soil and groundwater media;

- Source reduction/removal CMs will be evaluated to address impacted soils near and above the saturated interface. These CMs will be focused on near-surface soils within the immediate SWMU boundaries which can be effectively remediated using technologies such as vapor extraction, "hot spot" excavation/disposal, etc; and

- Groundwater mitigation CMs will be evaluated to address impacted groundwater associated with SWMU No. 17. These CMs will be focused on containment, control, and/or treatment of any impacted groundwater plumes. Further assessment efforts may be required to delineate the extent of impacted groundwater in order to evaluate and design appropriate CMs.

# Table 7-1
## Updated Investigation Threshold Levels (ITLs) for Soils (2002)
## RCRA Facility Investigation
## McDonnell Douglas Facility
## Hazelwood, Missouri

| Constituent | BOEING Investigation Threshold Level (ITL) for Soil (1) | Missouri CALM Residential Scenario A (2) | Missouri CALM Industrial Scenario C (3) | Missouri CALM Leaching to Groundwater (4) | EPA Region IX Preliminary Remediation Goals (5) |
|---|---|---|---|---|---|
| **VOLATILE ORGANIC COMPOUNDS (VOCs) (µg/kg)** | | | | | |
| Acetone | 1,600,000 | 2,700,000 | 8,700,000 | -- | 1,600,000 |
| Benzene | 50 | 6,000 | 13,000 | 50 | 650 |
| Bromodichloromethane | 700 | 11,000 | 41,000 | 700 | 1,000 |
| Dibromochloromethane | 800 | 20,000 | 77,000 | 800 | 1,100 |
| 2-Butanone (MEK) | 7,300,000 | 7,400,000 | 16,000,000 | -- | 7,300,000 |
| Carbon disulfide | 360,000 | 630,000 | 721,000 | -- | 360,000 |
| Carbon tetrachloride | 130 | 200 | 500 | 130 | 240 |
| Chloroform | 240 | 800 | 1,000 | 600 | 240 |
| 1,1-Dichloroethane | 590,000 | -- | -- | -- | 590,000 |
| 1,1-Dichloroethene | 54 | 400 | 1,000 | 90 | 54 |
| 1,2-Dichloropropane | 40 | 10,000 | 25,000 | 40 | 350 |
| Isopropyl benzene | 160,000 | 210,000 | 210,000 | -- | 160,000 |
| Napthalene | 24,000 | 120,000 | 240,000 | 24,000 | 56,000 |
| P-Isopropyltoluene | 67 | 8,760,000 | 8,760,000 | 67 | -- |
| cis-1,2-Dichloroethene | 500 | 1,200,000 | 1,200,000 | 500 | 43,000 |
| trans-1,2-Dichloroethene | 1,000 | 2,900,000 | 3,100,000 | 1,000 | 63,000 |
| Ethylbenzene | 32,000 | 400,000 | 400,000 | 32,000 | 230,000 |
| 2-Hexanone | -- | -- | -- | -- | -- |
| 4-Methyl 2-pentanone (MIBK) | 790,000 | 1,000,000 | 2,300,000 | -- | 790,000 |
| Methyl Tertiary-Butyl Ether (MTBE) | 67 | 8,760,000 | 8,760,000 | 67 | -- |
| Methylene chloride | 20 | 51,000 | 150,000 | 20 | 8,900 |
| Tetrachloroethene | 100 | 40,000 | 120,000 | 100 | 5,700 |
| Toluene | 3,700 | 650,000 | 650,000 | 3,700 | 520,000 |
| 1,1,1-Trichloroethane | 3,500 | 1,200,000 | 1,200,000 | 3,500 | 630,000 |
| 1,1,2-Trichloroethane | 40 | 5,000 | 14,000 | 40 | 840 |
| Trichloroethene | 100 | 40,000 | 89,000 | 100 | 2,800 |
| Vinyl Chloride | 20 | 300 | 600 | 20 | 150 |
| Xylenes, Total | 16,000 | 418,000 | 418,000 | 16,000 | 210,000 |
| Total Petroleum Hydrocarbons (TPH) | 200,000 | 200,000 | 1,000,000 | -- | -- |
| **POLYNUCLEAR AROMATIC HYDROCARBONS (PAHs) (µg/kg)** | | | | | |
| Acenaphthene | 1,000,000 | 1,700,000 | 5,400,000 | 1,000,000 | 3,700,000 |
| Acenaphthylene | 2,300 (6) | -- | -- | -- | -- |
| Anthracene | 8,500,000 | 8,500,000 | 27,000,000 | 33,000,000 | 22,000,000 |
| Benzo(a)anthracene | 200 | 1,000 | 4,000 | 200 | 620 |
| Benzo(b)fluoranthene | 600 | 900 | 4,000 | 600 | 620 |
| Chrysene | 200 | 36,000 | 140,000 | 200 | 62,000 |
| Fluoranthene | 1,600,000 | 1,600,000 | 5.2E+06 | 3,800,000 | 2,300,000 |
| Fluorene | 1,100,000 | 1,100,000 | 3.6E+06 | 2,100,000 | 2,600,000 |
| **POLYCHLORINATED BIPHENYLS (PCBs) (µg/kg)** | | | | | |
| PCBs | 220 | 600 | 2,500 | 18,000 | 220 |
| **METALS/CYANIDE (mg/kg)** | | | | | |
| Arsenic | 11 | 11 | 14 | -- | 22 |
| Barium | 1,700 | 14,000 | 51,000 | 1,700 | 5,400 |
| Cadmium | 11 | 110 | 380 | 11 | 37 |
| Chromium | 38 | 2,100 | 4,500 | 38 | 210 |
| Lead | 260 | 260 | 660 | -- | 400 |
| Mercury | 0.6 | 0.6 | 1 | 3.2 | 23 |
| Selenium | 4.3 | 300 | 970 | 4.3 | 390 |
| Silver | 26 | 140 | 450 | 26 | 390 |

Listed constituents are potentially anticipated in Environmental Field Investigation of Tract I South.
-- Applicable value not available, µg/kg = micrograms per kilogram, mg/kg = milligrams per kilogram

**Footnotes:**

1 Investigation Threshold Levels (ITLs) for soils were derived from the most conservative of Cleanup Levels for Missouri (September 2001) or USEPA Region IX Preliminary Remediation Goal (PRG) values.
2 Cleanup Levels for Missouri, September 2001. Value represents Residential (Scenario "A") exposure pathway.
3 Cleanup Levels for Missouri, September 2001. Value represents Industrial (Scenario "C") exposure pathway.
4 Cleanup Levels for Missouri, September 2001. Value that is protective of "leaching to groundwater."
5 USEPA Region IX Preliminary Remediation Goals (PRGs), November 1, 2000. Value represents Residential exposure pathway.
6 Alternative value acquired by using residential value for pyrene as a comparable surrogate.

## Table 7-2
## Updated Investigation Threshold Levels (ITLs) for Groundwater (2002)
## RCRA Facility Investigation
## McDonnell Douglas Facility
## Hazelwood, Missouri

| Constituent | BOEING Investigation Threshold Level (ITL) for Groundwater (1) | Missouri CALM Groundwater Target Conc (GTARC) (2) | USEPA Drinking Water Standards (MCLs) (3) |
|---|---|---|---|
| **VOLATILE ORGANIC COMPOUNDS (VOCs) (µg/L)** | | | |
| Acetone | 4,000 | -- | 4,000 |
| Benzene | 5 | 5 | 5 |
| Bromodichloromethane | 80 | 80 | 80 |
| Dibromochloromethane | 80 | 80 | 80 |
| 2-Butanone (MEK) | 1,900 (4) | -- | -- |
| Carbon disulfide | 1,000 (4) | -- | -- |
| Carbon tetrachloride | 5 | 5 | 5 |
| Chloroform | 80 | 80 | 80 |
| 1,1-Dichloroethane | 4,000 | 4,000 | 4,000 |
| 1,1-Dichloroethene | 7 | 7 | 7 |
| 1,2-Dichloropropane | 5 | 5 | 5 |
| Isopropyl benzene | -- | -- | -- |
| Napthalene | 100 | 100 | -- |
| P-Isopropyltoluene | -- | -- | -- |
| cis-1,2-Dichloroethene | 70 | 70 | -- |
| trans-1,2-Dichloroethene | 100 | 100 | -- |
| Ethylbenzene | 700 | 700 | 700 |
| 2-Hexanone | -- | -- | -- |
| 4-Methyl 2-pentanone (MIBK) | 160 (4) | -- | -- |
| Methyl Tertiary-Butyl Ether (MTBE) | 20 | 20 | -- |
| Methylene chloride | 5 | 5 | 5 |
| Tetrachloroethene | 5 | 5 | 5 |
| Toluene | 150 | 150 | 1,000 |
| 1,1,1-Trichloroethane | 200 | 200 | 200 |
| 1,1,2-Trichloroethane | 5 | 5 | 5 |
| Trichloroethene | 5 | 5 | 5 |
| Vinyl chloride | 2 | 2 | 2 |
| Xylenes, Total | 320 | 320 | 10,000 |
| Total Petroleum Hydrocarbons (TPH) | 10,000 | 10,000 | -- |
| **POLYNUCLEAR AROMATIC HYDROCARBONS (PAHs) (µg/L)** | | | |
| Acenaphthene | 1,200 | 1,200 | -- |
| Acenaphthylene | -- | -- | -- |
| Anthracene | 9,600 | 9,600 | -- |
| Benzo(a)anthracene | 0.0044 | 0.0044 | 80 |
| Benzo(b)fluoranthene | 0.0044 | 0.0044 | -- |
| Chrysene | 0.0044 | 0.0044 | 10 |
| Fluoranthene | 300 | 300 | -- |
| Fluorene | 1,300 | 1,300 | -- |
| **POLYCHLORINATED BIPHENYLS (PCBs) (µg/L)** | | | |
| PCBs | 0.5 | 0.5 | 0.5 |
| **METALS (µg/L)** | | | |
| Arsenic | 50 | 50 | 5 |
| Barium | 2,000 | 2,000 | 2,000 |
| Cadmium | 5 | 5 | 5 |
| Chromium | 100 | 100 | 100 |
| Lead | 15 | 15 | 15 |
| Mercury | 2 | 2 | 2 |
| Selenium | 50 | 50 | 50 |
| Silver | 100 | 100 | 100 |

Listed constituents are potentially anticipated in Environmental Field Investigation of Tract I South.
-- Applicable value not available, µg/L = micrograms per liter

**Footnotes:**

1 Investigation Threshold Levels (ITLs) for groundwater were derived from Cleanup Levels for Missouri (CALM). For instances where the CALM values were unavailable, Maximum Contaminent Levels (MCLs) were used. If CALM and MCL values were unavailable, Region IX Preliminary Remediation Goals (PRG) values for tap water were used as referenced below.
2 Cleanup Levels for Missouri, September 2001. Value represents groundwater target concentration value.
3 Maximum Contaminant Levels, Summer 2000, non-zero MCLG, MCL, or HBL.
4 Alternative value acquired from EPA Region IX PRGs, November 1, 2000.

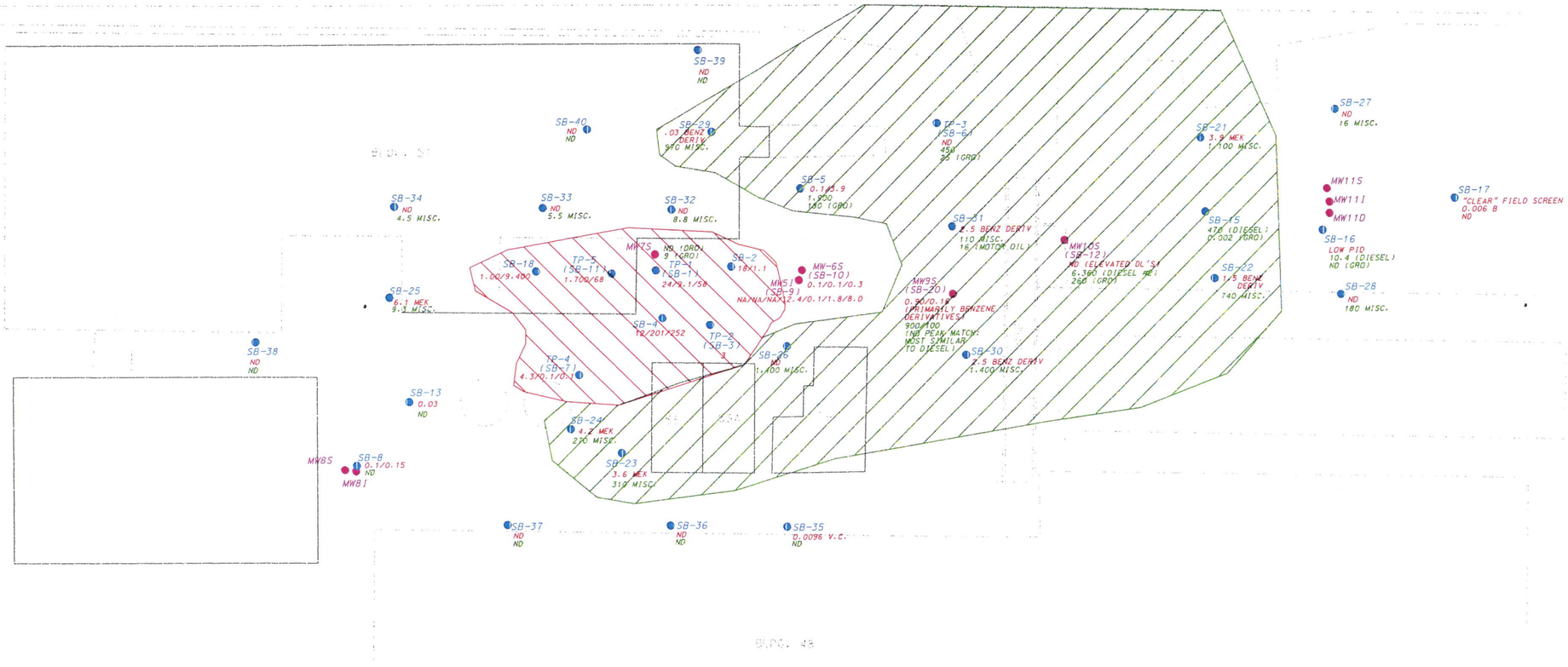
## Table 7-3 Groundwater Monitoring Well Sampling and Corresponding Laboratory Analysis Schedule for 2002, McDonnell Douglas RFI

| Sample Information | | | | Methodology | | Laboratory & Field Analyses* | | | |
|---|---|---|---|---|---|---|---|---|---|
| *Sample ID* | *Location* | *2001 & Q1-2002 Results* | *Proposed Frequency* | *Sample Method* | *Low Flow?* | *8260B* | *TPH DRO* | *Lab Bio Parameters* | *Field Bio Parameters* |
| MW-8S | Southwest | Low PCE/MTBE in 2001; upgradient bio sample point | Quarterly | Peristaltic | | VOCs | TPH (diesel fraction) | Lab Bio Parameters | DO, ORP, Fe+2 |
| MW-8I | Southwest | PCE detected in Q4, no detections Q1 2002 | Quarterly | Bladder | | VOCs | TPH (diesel fraction) | Lab Bio Parameters | DO, ORP, Fe+2 |
| TP-4 | South | Consistent VOCs & TPH | Semi-Annual | Bailer | | VOCs | TPH (diesel fraction) | | |
| TP-23 | Southeast | Proposed new piezomenter | Quarterly | Bailer | | VOCs | TPH (diesel fraction) | | |
| MW-5I | Source | High concs, but decreasing; change in degradation products; bio sampling point | Quarterly | Bladder | | VOCs | TPH (diesel fraction) | Lab Bio Parameters | DO, ORP, Fe+2 |
| MW-6S | Source | Consistent VOCs & TPH; bio sample point (final stage) | Semi-Annual | Peristaltic | | VOCs | TPH (diesel fraction) | Lab Bio Parameters | DO, ORP, Fe+2 |
| TP-2 | Source | Consistent; V.C. detected in Q4 | Semi-Annual | Bailer | | VOCs | TPH (diesel fraction) | | |
| MW-7S | Source | High consistent DCE, TCE, PCE; bio sample point | Semi-Annual | Peristaltic | | VOCs | TPH (diesel fraction) | Lab Bio Parameters | DO, ORP, Fe+2 |
| TP-3 | East | Primarily TPH concern; checkpoint for off-site migration | Quarterly | Bailer | | VOCs | TPH (diesel fraction) | | |
| MW-9S | East | TPH product issues; TCE in Q4; bio sample point | Quarterly | Peristaltic | | VOCs | TPH (diesel fraction) | Lab Bio Parameters | DO, ORP, Fe+2 |
| MW-10S | East | TPH product issues; no chlorinated VOCs thus far | Semi-Annual | Bailer | | VOCs | TPH (diesel fraction) | | |
| TP-6 | East | TCE hit Q4, decreasing TPH; only 3 historical data points | Quarterly | Bailer | | VOCs | TPH (diesel fraction) | | |
| MW-11S | East | TCE/PCE > ITL in Q2 only; important horiz boundary | Quarterly | Bailer | | VOCs | TPH (diesel fraction) | | |
| MW-11I | East | Consistent ND's | Quarterly | Bladder | | VOCs | TPH (diesel fraction) | | DO, ORP, Fe+2 |
| MW-11D | East | TCE > ITL in Q3 & <ITL in Q4; important horiz boundary | Quarterly | Bladder | Y | VOCs | TPH (diesel fraction) | Lab Bio Parameters | DO, ORP, Fe+2 |

Lab Biodegradation Parameters: Chloride, total iron, nitrate as N, nitrite as N, sulfate, sulfide, dissolved manganese, dissolved iron, TOC, DOC, methane, ethane, ethene, carbon dioxide.
* Collect duplicate samples (VOC and TPH) from 2 wells each event for QA/QC purposes

Piezometer TP-5 removed 11/14/01
Piezometer TP-1 not sampled due to proximity to MW-7S

| BIO Parameter Sampling Rational | |
|---|---|
| Upgradient: | MW-8S; MW-8I |
| Source Area: | MW-7S |
| Downgradient - Impacted: | MW-5I; MW-6S; MW-9S |
| Downgradient - Unimpacted: | MW-11D |




N

W E

S

SCALE 1"=40'

LEGEND

- MONITORING WELL
- Geoprobe Boring and/or Temporary Piezometer
- 5.4 TOTAL VOCs IN SOIL (mg/kg)
- VOC LEVELS ABOVE ITL
- 450 TPH IN SOIL (mg/kg)
- TPH LEVELS ABOVE ITL

# THE BOEING COMPANY

## Figure 7-1

## Approximate Delineation of Constituents Above ITL's in Soil

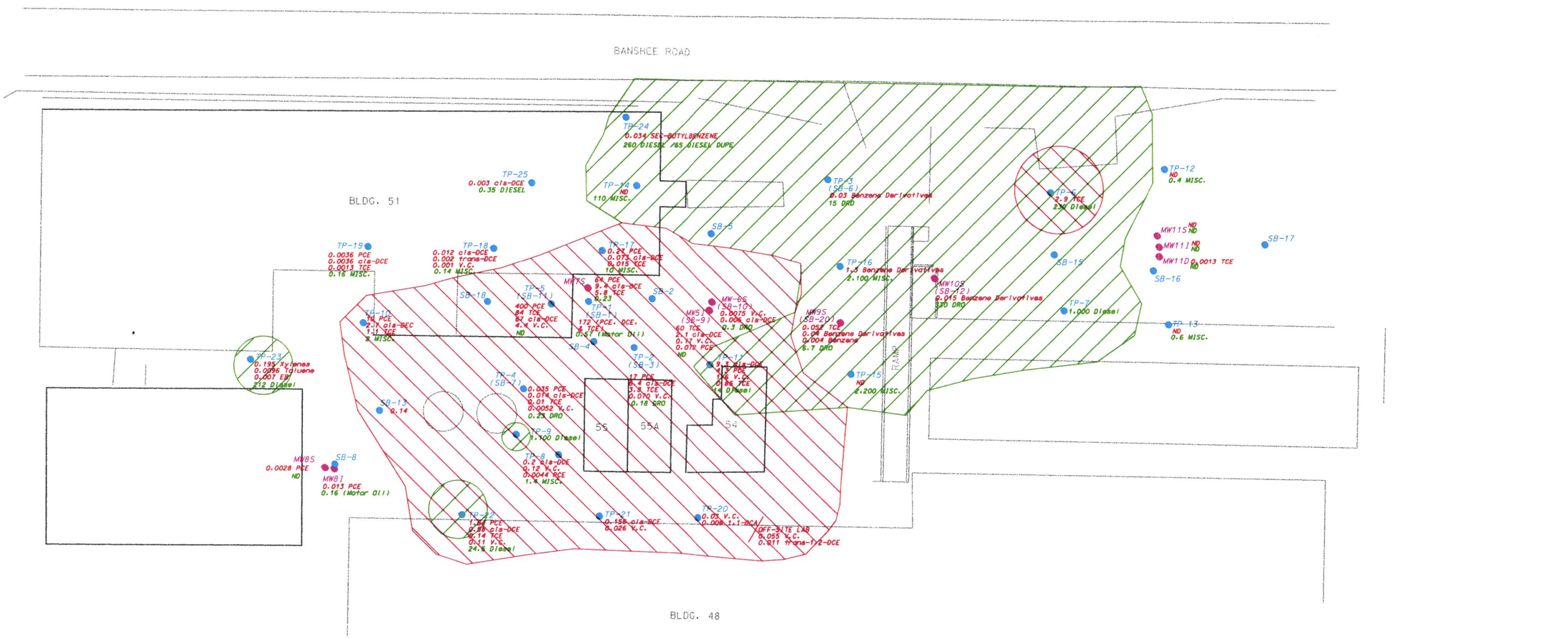

**Harding ESE**

A MACTEC Company

3199 Riverport Tech Center Drive

St. Louis, MO 63043

314-209-5900




SCALE 1"=40'

LEGEND

- MONITORING WELL
- Geoprobe Boring and/or Temporary Piezometer
- 5.4 TOTAL VOCs IN GROUNDWATER (mg/l)
- VOC LEVELS ABOVE ITL
- 450 TPH IN GROUNDWATER (mg/l)
- TPH LEVELS ABOVE ITL

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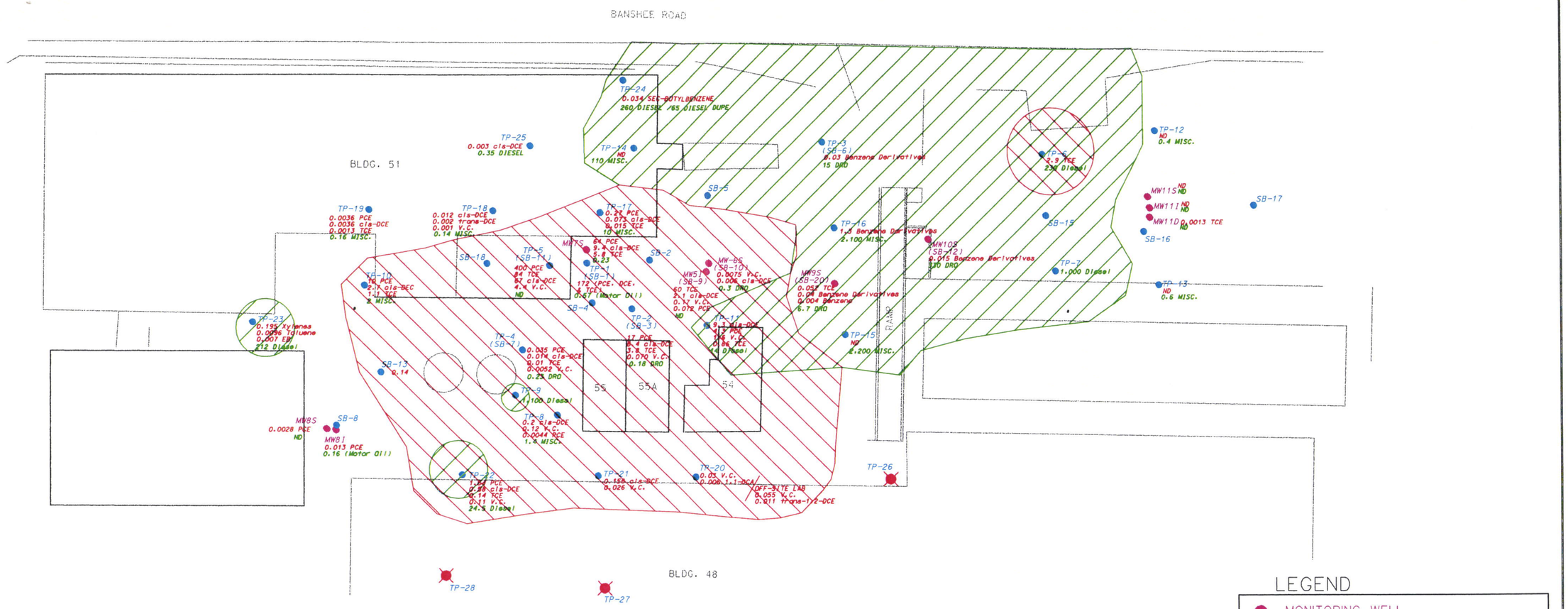
# THE BOEING COMPANY

## Figure 7-2

## Approximate Delineation of Constituents Above ITL's in Groundwater


**Harding ESE**
A MACTEC Company
3199 Riverport Tech Center Drive
St. Louis, MO 63043
314-209-5900

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## Figure 7-3
## Proposed-Soil Boring and Temporary Piezometer Location Map


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